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PUNJAB CANAL GAZETTEERS.

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LOWER JHELUM CANAL, 1920.

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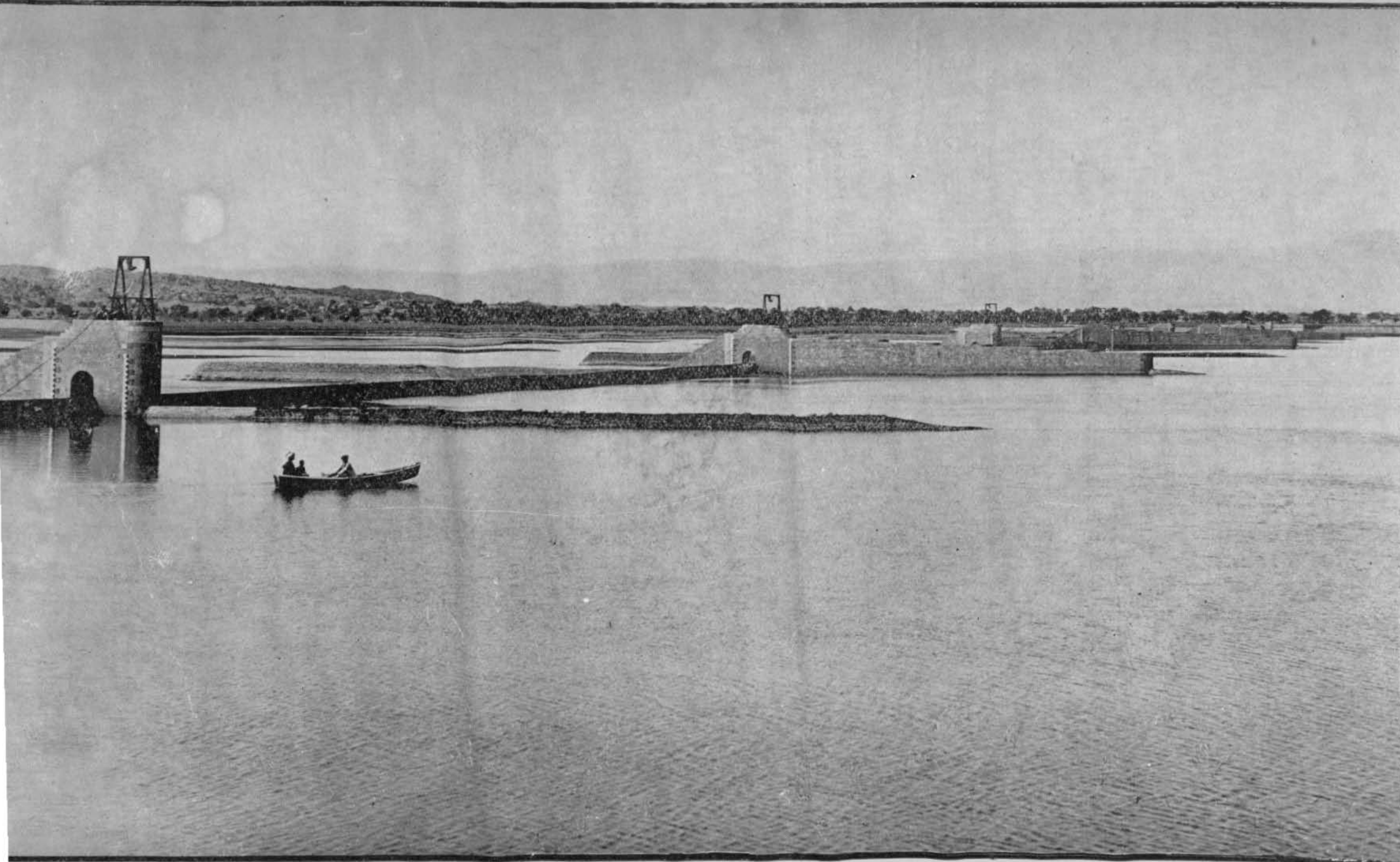
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MAPS AND PLANS.

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A PART OF RASUL WEIR FROM UPSTREAM. Plate 2.



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The weir is 4100 feet long. There are 7 piers and long groynes running up and downstream.

GAZETTEER

OF THE

LOWER JHELUM CANAL.

CHAPTER I.

History of the Project.

CHAP. I.

History of the Project.

The Lower Jhelum Canal takes off from the left bank of the River Jhelum at Rasul, and commands by flow the greater part of the Jhech Doab, that is the greater part of the Shahpur and Jhang Districts lying between the Jhelum and Chenab Rivers. From the Shahpur District boundary, 55 miles west of the town of Gujrat, the irrigated tract extends down to the confluence of the two rivers which give this *Doab* its name of Jhech (a contracted combination of the names Jhelum and Chenab). On the General Irrigation Map of the Punjab (Plate I) its position is in the north-west of the green-washed areas.

In 1860 the Deputy Commissioner of Shahpur (Mr. Macnabb) at his own expense cleared a silted-up arm of the river, and so prepared the irrigation canal called the Macnabbwah. He also induced Malik Sahib Khan, Tiwana, to excavate a canal to irrigate block of waste land which had been granted to him at Kalra. These early canals proved profitable and encouraged further enterprise of the same sort. In 1893 there were four State-owned, and sixteen private, canals in this district. In a favourable year from 50,000 to 57,000 acres were irrigated by these canals, the cost of construction of which was not great. The irrigated area consisted of low land lying along the margin of the river; the uplands, lying above the level of river floods, were not irrigated; and the river's flow, at canal heads, was uncontrolled, the water entering the canals only when the rivers rose in flood high enough to spill into them naturally.

In 1880 Mr. Catton, Executive Engineer, was deputed to Shahpur, to examine the State Canals, and to make proposals for improving and extending them in order to convey water to the uplands of the *Bar* in the Bhera and Shahpur Tehsils, and to formulate suggestions for their better management. During the course of this enquiry, conducted in the cold seasons

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of 1880-81 and 1881-82, Mr. Catton surveyed a line of levels from Chak Nizam, which led him to believe that, instead of merely improving the existing Canals, confined as they were to the strip of comparatively low ground near the edge of the river, it would be possible to construct an Inundation Canal from Chak Nizam for the irrigation of the high land between the Chenab and Jhelum Rivers. In pursuit of this idea the surveys necessary for the preparation of a complete contoured map of the Doab were undertaken. In 1885 a project was prepared for an Inundation Canal, which, though feasible, and likely to be remunerative, was, after some consideration, abandoned in favour of a project for a perennial canal offtaking from a point higher up the river.

In 1887 Major Ottley prepared a project to command 1,323 square miles, or 846,720 acres; of which one-half, or 423,360 acres, were to be irrigated annually. The Kharif irrigation was to be 141,220 acres, and the Rabi 282,240 acres. The Rabi discharge was fixed at 2,313 cubic feet per second, and the Kharif at 2,875; which latter determined the size of the main channel taking off from the river. There were to be 175 miles of main canals and 569 miles of distributary channels. The Head-works were to consist of a Canal Regulator having 30 openings, each 6 feet wide; Undersluices, having 33 openings, each 20 feet wide, and a weir 8,610 feet long. It was estimated that the project would cost Rs. 1,40,50,000 nearly, and would bring in a net annual return of 7·1 per cent.

Colonel F. Home, R. E., Officiating Chief Engineer, revised the design and amended the estimate. He calculated that by lowering the canal bed level at its Head, by modifying the gradient, and by altering the off-takes of Branches and alignments, savings amounting to 9 lahks of rupees could be effected; and still more by reducing the length of weir and undersluices. The final cost of the project, as amended, stood at about Rs. 125 lakhs, and this estimate was duly sanctioned in 1888.

In the winter of 1888-89 construction was commenced. The main canal was aligned, and the site of the Head-works finally fixed. These early operations were then suspended, as it was decided to push on first with the Lower Chenab Colony Canal, which was in a more advanced state of construction at the time. It was not until 1897 that the construction of the Lower Jhelum Canal was resumed. In the year 1900 the scope of the project was greatly extended and its estimates were revised.

The gross area brought under command was increased to 1,139,500 acres, or 1,780 square miles; the idea being to render it possible to irrigate every irrigable acre within the Doab, down to the limit of land which can be inundated naturally by river spills. This revised estimate provided, at a cost of Rs. 1,39,14,941, for a canal of 140 feet bed-width, and 7·5 feet depth of water, and an estimated capacity of 3,800 cusecs.

Work was rapidly carried on, and in October 1901 the canal was opened by Sir Mackworth Young, Lieutenant-Governor of the Punjab. This did not mean that the canal, with all subsidiary channels, was complete, but that the works were sufficiently advanced for colonization and irrigation to make a beginning.

In the year 1904 the project was further revised and modified, in order to reconcile its scope with that of the newly-formed project known as the Triple Canal Project. It was proposed to construct a branch canal, called the Shahpur Branch of the Lower Jhelum Canal, *to supersede the existing* State and Private Canals along the left bank of the River Jhelum.

In the year 1900, after the abnormal drought of 1899-1900, the irrigators from the Government Inundation Canals of the Shahpur District petitioned the Lieutenant-Governor, asking that those Canals might be linked on to the Lower Jhelum Canal, and kept perennially in flow; whilst the private canal owners in the same district also expressed fears as to the possible effect, on their canals, of the off-take from the River Jhelum, of the Lower Jhelum Canal. Mr. Wilson, Settlement Commissioner, who had also previously been Deputy Commissioner, Shahpur, and Settlement Officer of the Bhera and Shahpur Tahsils, *recommended* the extension of perennial irrigation to the tract which was then irrigated *by inundation canals.* He scouted the idea of risk of water-logging resulting from perennial irrigation, and pointed to the increase of prosperity that would result from such irrigation. The Lieutenant-Governor, Sir M. Young, in a note, dated 1st March 1901, condemned Mr. Wilson's scheme of perennial irrigation, and recommended systematic action, with the object of gradually buying up all the private canals, as proposed by Mr. Tupper, Financial Commissioner.

Mr. Wilson, in a note dated 28th February 1903, recommended the offer of the following terms to the proprietors of the private canals:—

1*st.*—Perennial irrigation for 85 per cent of their land.

2nd.—Free irrigation for 5 years for 6,000 acres annually of land belonging to Mr. Mubariz Khan and 5,000 acres belonging to M. Hakim Khan and his cousin. After that irrigation at half rates for another 5 years on the same areas.

3rd.—After 10 years, Government to be under no obligation to those landowners, and to have a free hand to treat their irrigation in accordance with its general policy.

4th.—Canal owners to surrender their canals, and all rights enjoyed as canal-owners, into the hands of Government.

These terms were agreed to by the Lieutenant-Governor, Sir C. Rivaz, on the recommendation of Mr. Benton, Chief Engineer. Soon after this the Punjab Minor Canals Act was passed, and proceedings were taken for the acquisition of the private canals in accordance with that Act. The canal-owners, however, refused to accept the sums offered to them, by way of compensation, by the assessing officials. This stage was arrived at in the year 1908.

Meanwhile the construction of the Shahpur Branch of the Lower Jhelum Canal was begun in 1905; and it continued until the year 1910, when it was realized that the off-take of the Upper Jhelum Canal from the River Jhelum was not likely to seriously impair the interests of the inundation canals. By this time Rs. 8,78,107 had been spent on the Shahpur Branch, out of an estimated total cost of Rs. 16,17,134.

Sir J. Benton, Inspector-General of Irrigation, in a note, dated 30th January 1911, recommended to the Government of India that the Shahpur Branch *should be completed;* and gave, *inter alia*, the following reasons for his opinion :—

(1) The Shahpur Inundation Canals ought to be made perfectly secure against the inevitable reduction of the river's discharge which would follow upon the opening of the Upper Jhelum Canal in 1915.

(2) It was desirable to be able to supply water to the Private Canals in time to obviate damage to their crops in 1915.

(3) The cold weather supply of the River Jhelum would shrink rapidly in October, *which is a vital month.*

(4) The reduction of the river's flow would be very considerable in September, and likely to cause appreciable lowering of water surface.

(5) The reduction of the river's flow in October would amount to the entire volume in 3 or 4 years (*sic*).

In reply to the Government of India, the Punjab Government, in November 1911, remarked that the conclusions arrived at by Sir J. Benton appeared to be due to insufficient local knowledge of existing conditions, and pointed to the following facts :—

(*a*) That the Shahpur Inundation Canals (including the private canals) closed naturally during September, whilst the Triple Canal Project would not need Jhelum River water till October.

(*b*) That some delay might occur in the dates of opening of the inundation canals in the spring, but that the effect of this could not be serious, as, during the early part of April, *Kharif* operations were only beginning.

(*c*) That the damage to *Rabi* crops, estimated by Sir J. Benton at 20 or 30 *lakhs* of rupees, could not possibly occur as a consequence of delay in opening the inundation canals, as the *Rabi* crop does not in any case receive water from these canals.

(*d*) That the water rates assumed by Sir J. Benton, in his estimate of revenue from the Shahpur Branch, were incorrect, and that the probable revenue derived from its completion would be less than the existing revenue.

Meanwhile the re-settlement of the land revenue of the Shahpur District was in progress, and the further consideration of the Shahpur Branch Canal was shelved, pending the completion of the settlement. This occurred in 1912; and in 1913 Mr. Maynard, Commissioner, Rawalpindi Division, recommended the acquisition of the Private Canals, and the completion of the Shahpur Branch as a perennial canal. Mr. Maynard advised addressing the private canal-owners as follows :—

"It has been decided to complete the Shahpur Branch Canal, which will supersede the irrigation of your canals and deprive you of the right to levy *chaharami* dues. Your canals may incidentally be utilized as portions of subsidiary channels, but will cease as means of irrigation in their present form. To 27,000 acres of your proprietary land we will give irrigation from the Shahpur Branch, to such extent, and at such times, as it may be available, and with due regard to the claims of other

CHAP. I.
History of the Project.

irrigators; and for this we will charge, as water rate, only the working expenses, which we provisionally fix for the present, at Re. 1-4-0 per acre.

"In compensation for the loss of *chaharami* rights we will distribute among you perpetual *jagirs* of the maximum value of Rs. 24,000 in all."

These proposals were discussed at a Conference of Civil and Irrigation Officers which assembled at Simla on the 14th August 1914, and arrived at the following opinions :—

(1) It cannot be definitely stated that any real injury has been done to the present inundation canal system by the opening of the Lower Jhelum Canal. The opening of Upper Jhelum Canal must, however, result in further retarding the opening and hastening the closing of the inundation canals, and the areas irrigated must inevitably be reduced to some extent, but any definite forecast of the amount of reduction is impossible.

(2) The Shahpur Branch should be worked as a *Kharif* channel, only providing first waterings for the *Rabi*, but closing on or before 15th October. Flood embankments should be constructed so as to exclude river floods from the irrigated tract, and irrigation arrangements should be modified to obviate channels crossing drainages.

(3) The probable cost of completion of the Shahpur Branch will be Rs. 14,00,000 over and above the sum of Rs. 8,78,107 already spent; which latter must be regarded as a dead loss, and kept out of future accounts.

(4) The net additional income likely to be realized by the Shahpur Branch, if completed, will be Rs. 86,290.

(5) The compensation to private canal-owners proposed by Mr. Maynard is fair. It amounts to Rs. 5,00,000, which added to Rs. 14,00,000 will make the total cost to Government of the Shahpur Branch Rs. 19,00,000. The estimated net revenue, Rs. 86,290 per annum, will give a return of 4·54 per cent on this expenditure.

The recommendations of the Simla Conference of August 1914 were approved of by the Punjab Government, and by the Government of India; which latter sanctioned the completion

of the Shahpur Branch as a *Kharif* canal, on the understanding that its total future cost of construction (ignoring the money already spent on it) *plus* the capitalized value of the compensation to be paid to the private canal-owners should not exceed 25 times the estimated net additional revenue expected to accrue from it. The Commissioner of Rawalpindi (Colonel Popham Young) was authorized to offer to the private canal-owners compensation on the lines proposed by Mr. Maynard; and he did so; but the terms were refused by the canal-owners.

Colonel Popham Young then suggested a fresh offer, still more favourable to the Maliks (canal-owners) as follows:—

(*a*) Irrigation to be given at concession rates to the whole area (approximately 35,000 acres) held in proprietary right by the canal-owners, and already classed as *nahri*.

(*b*) The concession rate to be Re 1-8-0 per acre, compounded of Re. 0-12-0 royalty and Re. 0-12-0 on account of maintenance charges.

(*c*) Irrigation to be given at the same concession rates, which will be paid by the canal-owners, to the area (approximately 20,000 acres), classed as *nahri* in respect of which *chaharami* has been paid to the private canal-owners in the past, and the right of the canal-owners to take *chaharami* to be continued.

The Punjab Government approved of this offer, only altering the figure 35,000 in (*a*) to 30,000, on the ground that the average sowings in the past had been less than 27,000 acres. The Maliks, however, refused even this offer; but put forward counter-proposals, which were unacceptable by Government for the following reasons, as stated by Colonel Popham Young:—

"We cannot concede the request that the royalty should remain at Re. 0-4-0 per acre, if only for the reason that the income derivable from the Shahpur Branch would be so reduced that the completion of the project on a 4 per cent basis would be impossible. We cannot grant compensation for the extinction of the *chaharami* rights at 20 years' purchase, for the reason that the cost of the project would exceed the figure on which we would hope to earn the same irreducible minimum of 4 per cent. It comes to this then that we cannot complete the Shahpur Branch on the basis of an agreement

with the private canal-owners, to which they will be willing subscribers. Agreement under pressure it is not our desire to arrive at, even if such a thing were possible."

The Government of India then, in letter No. 547-I., dated 5th August 1916, agreed to the abandonment, for the time, of the scheme for the completion of the Shahpur Branch of the Lower Jhelum Canal.

The construction account of the Lower Jhelum Caral Project could have been closed with effect from the year 1904, but for the question of the construction of the Shahpur Branch as a corollary to the Triple Canal 'roject of 1904. The date of closure of the construction account was postponed from year to year, until, after the abandonment of the Shahpur Branch Canal Project in 1916, it was decided to close the construction account of the Lower Jhelum Canal with effect from the 31st March 1917.

As matters now stand (A. D. 1920) tne gross area commanded by direct gravitation flow by the Lower Jhelum Canal is 1,368,398 acres. The area which the Government undertakes to irrigate annually is 668,921 acres, *viz.*, 256,307 acres in the *Kharif* and 412,614 acres in the *Rabi* season. 1he area actually irrigated annually on the average of the past five years (ending 31st March 1919) was 855,079 acres, *viz.*, 290,143 acres in Kharif and 564,936 acres in the *Rabi* season.

THE 'BAR' BEFORE COLONIZATION. Plate 1.



Here the 'Bar' is seen in its natural condition before the introduction of canal irrigation.
At this site the jungle growth in the foreground is less than usual. The ragged clumps of trees are characteristic

CHAPTER II.

DESCRIPTION OF THE TRACT COMMANDED BY THE CANAL.

CHAP. II.

Description of the Tract commanded by the Canal.

The Jhech Doab, or tract between the rivers Jhelum and Chenab, down to their confluence, consists of land described locally, in the vernacular, as *Hithar*, *Nakka* and *Utar* or *Bar*. The *Hithar* comprises the alluvial tracts immediately bordering on the rivers, subject to the fertilizing influence of river inundations. It is well-populated, and under cultivation in both summer and winter seasons. The Lower Jhelum Canal does not irrigate the two *Hithar* tracts, one along the Chenab and the other along the Jhelum. The *Nakkas* are narrow belts of land running down the Doab adjacent to the *Hithar* strips, just above the highest level of river floods, but within the zone of profitable irrigation from wells. In these tracts the villages are fewer, smaller, and in a less flourishing condition than those in the *Hithar*. Canal irrigation from the Lower Jhelum Canal has been extended to both *Nakkas*. The space between these belts of cultivation was occupied by an expanse of waste land known as the *Bar* or *Utar*.

The normal range of discharge of the River Chenab at Khanki is between 5,000 and 75,000 cubic feet per second, while the extreme limits, occasionally reached, are a winter minimum of 4,000, and a summer flood maximum of 700,000 cubic feet per second. The range of variation of flow of the Jhelum is very similar. The soils of the Chenab *Hithar* are generally lighter and more sandy, and inferior in productive power, than the richer loams of the *Bar* uplands and of the Jhelum *Hithar*.

In the bordering river valleys well-water is good and sweet, and a spring level relatively close to ground surface facilitates well-irrigation. Alongside the river is a strip of cultivation depending for its irrigation on river floods and wells. A little further from the river there is a belt of cultivated land thickly studded with wells, where spring level ranges from 15 to 30 feet below ground surface. In this tract numerous villages, wells, herds of cattle and verdant fields indicate a prosperous condition of things. Farther inland the outward signs of prosperity changed gradually for the worse, prior to the introduction of canal irrigation. The subsoil spring-level was lower down, at depths of from 45 to 60 feet; villages and wells were fewer, cultivation was in smaller patches confined to the vicinity of the wells. The *Bar* is now a flourishing colony. This upland tract is from 20 to 30 miles wide and about 60 miles long. The soil is generally an excellent loam, but varied with expanses of hard clay flats and with sand drifts, in the downstream direction,

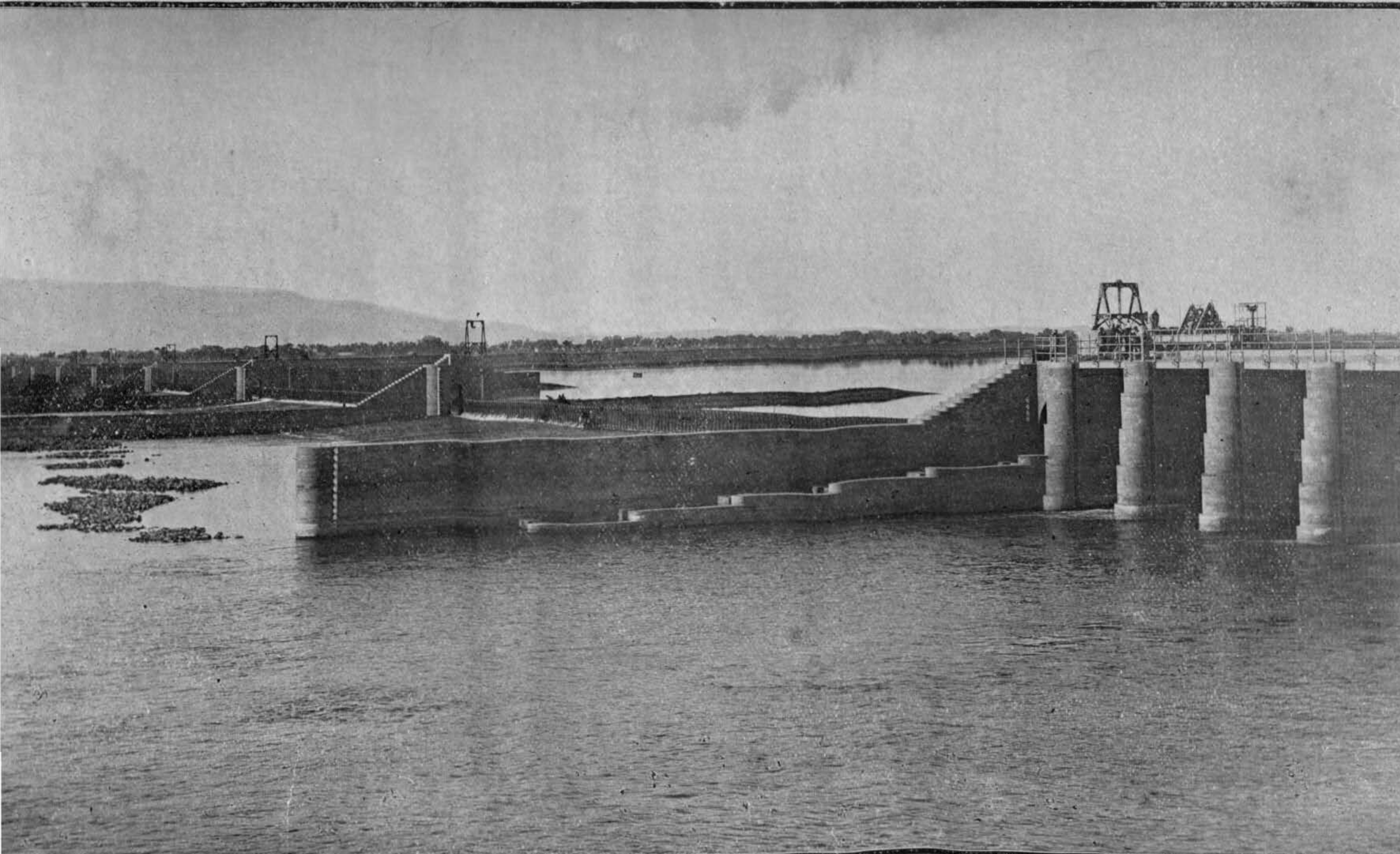
CHAP. II.

Description of the Tract commanded by the Canal.

towards the confluence of the rivers. Prior to the opening of the canal spring level was from 50 to 60 feet below ground surface in the centre of the *Bar* and the water more or less brackish. There were a few wells where some settlers had established themselves in the vicinity of the surface drainage lines. There was little cultivation, but generally a wilderness of shrubs, bushes, and stunted trees. After a fall of rain, grass, capable of supporting herds of cattle, sprouted from the soil. The average annual rainfall varied from 15 inches in the north-east, to about seven inches in the south-west. Of this, from 6 to 11 inches fell during the summer monsoon, and from 2 to 4 inches in the winter. On the whole the rainfall was scanty, variable, and badly distributed. The nomadic dwellers of the *Bar* were given to cattle-lifting, and the long streches of jungle growth facilitated such operations. The illustration facing page 9 gives an idea of the appearance of the *Bar* before it was irrigated and colonized.

Conditions were suitable for theintroduction of canal irrigation and colonization. There was *the soil*, excellent for the production of crops of every variety; the low spring level rendering irrigation from wells difficult; crown waste land available for settlers and grantees; an abundant perennial supply of water in the river; deficient, uncertain and ill distributed rainfall, and a dry atmosphere. The necessity for bringing river water on to the land by means of a perennial canal was clear.

RASUL UNDERSLUICES AND WEIR TAKEN FROM THE DOWNSTREAM LEFT BANK. Plate 3.



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On the right flank of the sluices can be seen the fish ladder. A small quantity of leakage through the

CHAPTER III.

DESCRIPTION OF THE CANAL AND ITS WORKS.

CHAP. III.

Description of the Canal and its Works.

The canal head-works are situated at Rasul, in the Gujrat District, on the left bank of the river Jhelum, at the extreme western end of the Pabbi range of hills; which is a spur of the outer Himalayas. Connected with the canal head regulator are the usual river-works, intended for the control of the river water-levels and of the canal supply.

The weir across the Jhelum River.

A submerged stone wall, with a stone masonry pavement downstream of it, and sloped at 1 in 15 ir the downstream direction, was laid across the river bed. This was called a weir. It was 4,000 feet long, and its top was approximately at the mean bed-level of the river. Hinged to the crest of the weir were steel shutters,* 6 feet high. They could be lowered to a flat position on the weir-crest, so as to offer no obstruction when the river was in flood, and they could be raised into a vertical position in the cold weather months in order to pond-up the low water-level suitably. The illustration in frontispiece is a view of the weir from upstream. The waterway is divided into 8 bays by 7 piers, with groynes upstream and downstream, intended to prevent the river from undermining the work by parallel flow. The shutters are shown in the illustration as erected and the water ponded up. On the piers which are spaced about 500 feet apart, are standards for carrying a ropeway, on which a light trolly can be run for transit to the opposite bank of the river.

*These steel shutters were removed in the year 1919 and the masonry crest of the weir was built up to R. L. 711·5, or about 3·5 feet higher than its original level.
F. W. W.

The sluices of the weir.

Between the Weir and Canal Regulator are the Weir Sluices; on the right flank of which is placed a fish-ladder. The sluices consisted of 12 openings, each 20·0 feet wide, controlled by 3 tiers† of steel gates, one above the other, operated from above by travelling winches. By means of these sluices, worked in combination with the weir shutters, the perennial flow of the river is drawn past the canal head regulator, which is adjacent to the sluices. The Punjab rivers, from March to October, are heavily charged with silt, the heavier particles of which it is desirable to keep out of the canal. The next illustration is a view from downstream of the undersluices, showing how trifling is the amount of leakage that passes through the drop shutters over the weir-crest when the river water is held up.

†Single gates, each 11 feet high, fitted with counter balance weights and gearing, on the "stoney" principle, were substituted, in the year 1919, for the 3 tiers of gates.
F. W. W.

CHAP. III.

Description of the Canal and its Works.

The canal head regulator.

The canal regulator has 24 vents,* each 6·5 feet wide, operated by drop gates. The masonry sills of these vents are three feet above the floor of the weir sluices; but in the flood season the sill level is raised four feet higher, or seven feet above sluice floor level, in order that the coarse bottom silt of the river may be kept out of the Canal.

* These 24 vents were altered, during the period 1916—1920, to 8 vents each 24·5 feet wide, controlled by silt gates of the radial arm design The masonry sill 3 feet high was replaced by one of reinforced concrete 6·67 feet high.
F. W. W.

On the left, as one looks down the canal, are situated the local engineers' residential quarters, and inspection houses for touring officers; and on the right are the quarters for the regulating work-people.

The main canal.

The canal off-takes with a sharp curve to the right, following for about 20 miles a course almost parallel to the river, but with a declivity less than that of the river, and a gradually increasing elevation, relatively to the river, till it is able to flow on to the high ground. After crossing the railway, the canal, turning to the left, recedes from the river; and at the 39th mile attains to full command of the land by gravitation flow; and here the first division of the supply takes place.

The bifurcation at Fakirian.

The illustration, giving a view from upstream, of the Fakirian Regulators, shows the off-takes of the Northern and Southern Branches, of the Southern Feeder and of the Dhori Distributary. On the right of the canal is situated the Mona Cavalry Remount Depôt, of which a brief notice will be found in another chapter.

The Northern Branch.

Proceeding along the Northern Branch, which follows a south-westerly course, many Falls, Bridges and Distributary heads are passed. At every 10 miles, or so, along the Canal system, are Rest-houses, built primarily for the touring Canal Engineer, but used also by all touring officers employed in the colony. At mile 34 another important division of the supply occurs. On the left is the continuation of the Northern Branch, which extends right down to the lower end of Doab; and on the right, the Sulki Branch, running down the Jhelum *Khadir* or *Hithar*, in the direction of Sahiwal, and feeding the Ghazni Distributary which terminates at Kadarpur. The photographic view of the Ludewala Regulator illustrates the off-take of the Sulki Branch from the Northern Branch. Some two or three miles downstream of this point, to the left, is the city and civil station of Sargodha; which is the administrative centre of the canal system and of the civil district.

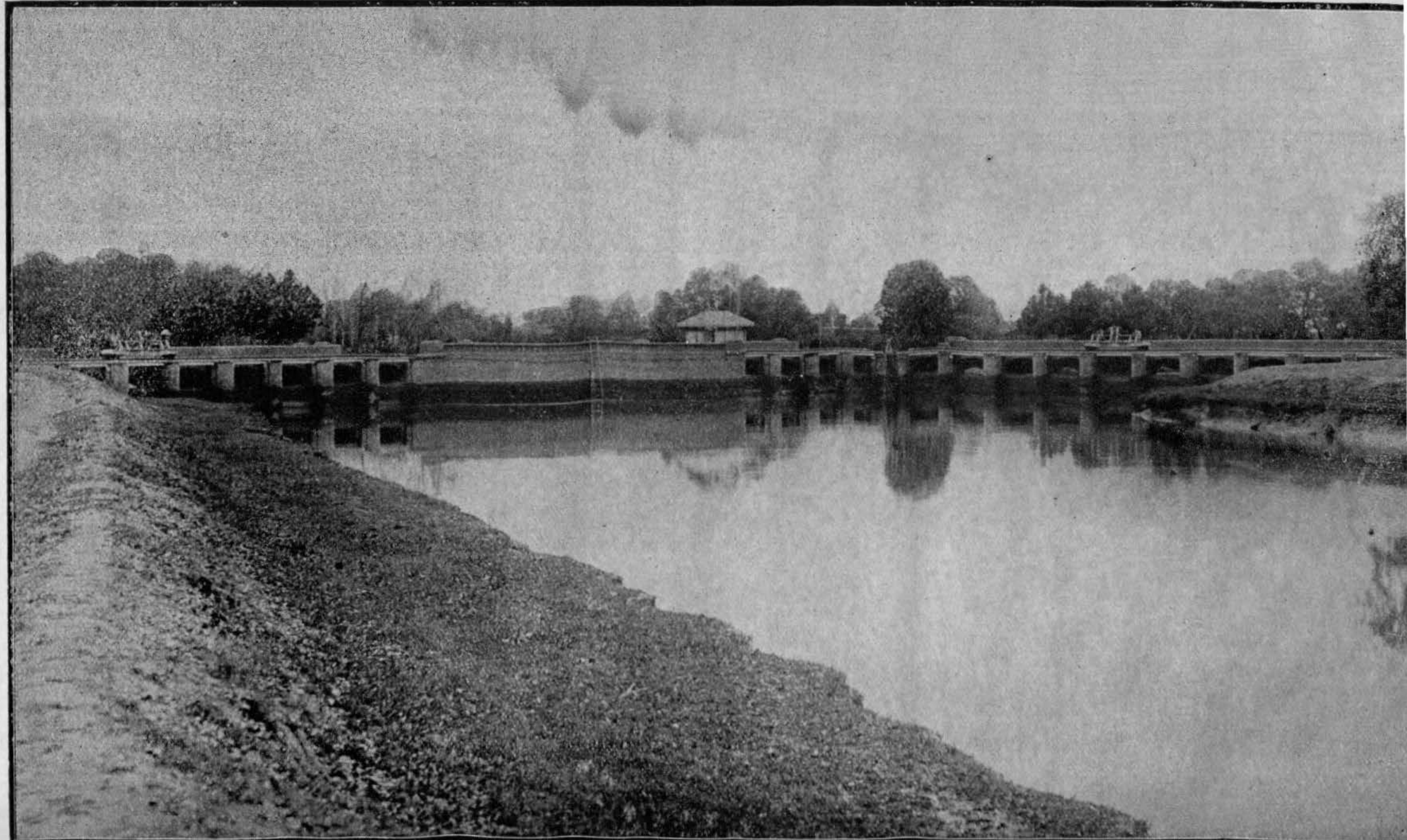


Photo-Mech. Dept. Thomason College, Roorkee.

On the left is the Southern Branch Head Regulator having 4 spans each 20 feet wide sub-divided into 8 openings each $8\frac{3}{4}$ feet wide. On the ex
right is the Northern Branch Head Regulator having 5 spans of 20 feet, similarly sub-divided. Between these two is the Head Regulator of



oto.-Mech. Dept. Thomason College, Roorkee.

The supply is here divided between the Sulki Branch on the right and the Northern Feeder in continuation of the Main Channel.
The Sulki Regulator has 3 spans of 16·5 feet sub-divided into 6 openings each 7·0 feet wide, and the other work is similar.

The Southern Branch. The Southern Branch, leaving the Main Canal at Fakirian, flows down the main watershed of the Doab to the Kirana hills. At mile 10 it throws off the Chenab *Khadir* Feeder and Distributary to the left, for the irrigation of the low land bordering on the Chenab River.

Mileage of channels. Besides 39 miles of main canal, there are 156½ miles of Branch Canals, 997 miles of distributary channels and something like 7,600 miles of water-courses, which supply water direct to the fields. It is the practice to feed the water-courses from distributaries, or minor State-owned channels; and not directly from the Main or Branch Canals.

The Main Canal was designed to a bed width of 140 feet to discharge 3,800 cubic feet per second. The Southern Branch was designed with a bed width of 80 feet, and water depth of 7·5 feet, to discharge 2,157 cubic feet per second; and the Northern Branch with a bed width of 94 feet, and a water depth of 6·0 feet to discharge 1,747 cubic feet per second. The gradient of the Doab from north-east to south-west is about two feet to the mile. The canal gradient is only nine inches to the mile; consequently it flows from the bottom of the river valley at Rasul to the ground surface of the watershed at Fakirian, over a distance of 40 miles. The gradient of the Branches is about one foot to the mile; so that vertical masonry falls are required at intervals to adjust the water surface levels of the canal to those of the land. The gradients of the smaller channels get steeper and steeper; and the water-courses have the same general slope as the ground surface.

Escapes. This canal has been provided with three emergency escapes; *viz.*, one from the Northern Branch into the Buddhi Nala, a deserted former channel of the River Chenab; another from the Sulki Branch into the river Jhelum; and the third from the Southern Branch into the Chenab River. When the canal was first made, and irrigation had not fully developed, these escapes were used to a considerable extent; but they have gradually become less frequently used, and have silted up more or less, as there is not now the same need for them.

Rest-houses. There are, in all, 55 permanent, and two temporary, rest-houses scattered over the gross commanded area of 2,020 square miles; which implies one Rest-house to every 37 square miles. The houses are so located as to bring the officials into close touch with the people, who have to travel, on the average, not more than four miles to meet the canal officers on tour, when the latter happen to visit the nearest rest-house.

CHAP. III.

Description of the Canal and its Works.
Mills.

Flour mills have been built at four sites. They have brought in good returns on the outlay incurred on them.

Telegraphs.

The Canal has been equipped with a telegraph system which extends from Rasul all over the canal system. There are in all 292 miles of wire and 37 telegraph stations. These telegraphic communications have given security to the works, have reduced the need for escapes, or spillway safety-valves, and have facilitated the efficient distribution of the supply.

After the completion of the construction account of the Lower Jhelum Canal, in March 1917, it was found necessary to remodel the canal system exhaustively, in order to bring it up to date, and improve its efficiency. As designed and constructed, the water surface of the main canal, branches and distributaries, was in many places at too low a level to permit of the irrigation of every acre of culturable soil, within the *Doab*, by gravitation flow.

Different plots of land, not commanded by gravitation flow from the canal, scattered all over the canal tract, amounted, in the aggregate, to an area of about 80,000 acres. It was not practicable, ordinarily, to colonise such land, because peasant colonists are reluctant to take up land which can only be irrigated by mechanical means of water-lift.

The remodelling project of 1917 aimed at arriving at an equitable distribution of water all over the irrigated area, and at regrading and remodelling all water channels, so as to raise their water surface level sufficiently high to enable the water to flow on to every acre of culturable soil by direct gravitation. It was arranged to give every portion of the canal system such a capacity as to ensure the irrigation, annually, of 75 per cent of the culturable area of every estate newly colonised, and to irrigate the same proportion of the culturable area of proprietary village land in the *Bar* or uplands, whilst allowing for the irrigation, annually, of 40 per cent of the culturable area of proprietary village land in the *Khadir* or *Hithar*. The reduction of water supply to the *Khadir* was intended to minimise the risk of water-logging relatively low-lying land.

Another important feature of the remodelling project of 1917 was the adoption of designs aiming at the exclusion, as far as possible, of coarse sand, or detritus, from the water entering the canal system. With this view, designs and estimates of the cost of remodelling the Head Works of the Canal at Rasul were prepared, and, in due course, sanctioned by the Government of India.

The Weir across the river at Rasul, which previously consisted of a masonry wall, built across the river, with its top at mean bed-level; and which had iron shutters, six feet high, hinged to its top, and capable of being raised erect in order to pond up the water surface of the river when the flow was scanty; and of being dropped flat with weir-crest in order to allow the unimpeded passage of floods of great magnitude; was remodelled, by the removal of the iron shutters, and the building-up of the masonry wall, solid, to an average height of 3½ feet above its original level. The gates of the weir sluices, which had previously consisted of three tiers of iron gates, sliding in vertical grooves, were removed, and replaced by single gates, 20 feet wide, and 11 feet deep, fitted with "Stoney" Patent Non-friction Roller Gear and Counter Balances.

The Canal Head Regulator, which had previously a waterway consisting of 24 openings, each 6½ feet wide, was remodelled so as to have 8 openings, each 24½ feet wide. It was furnished, also, with a reinforced concrete sill, or crest wall, 6⅔ feet high; whilst, behind this sill, a movable gate, sliding in vertical grooves, and worked by radial-arm gear and machinery, designed by Captain Ashford, Superintendent of the Central Canal Workshops, Amritsar, was capable of serving as a movable sill at higher levels; and of ultimately closing the canal head, by abutting, at its highest level, against a reinforced concrete breast-wall, or lintel. The object of this design was to pass water, in the flood season, when the river water was most highly charged with silt, from the river into the canal, over a sill raised to the highest possible level, with the water flowing at the lowest possible velocity.

The total cost of the remodelling project of 1917 amounted to about Rs. 28,50,000. It resulted in furnishing the canal with the full capacity of 4,320 cusecs.

It is a matter for consideration, in the immediate future, whether the capacity of the Lower Jhelum Canal system should not be increased by about 50 per cent, throughout, so as to enable it to irrigate larger areas annually during the *Kharif* season, when the water supply is abundant; rendering it less necessary to irrigate as large areas, as it does at present, during the *Rabi* season, when water is scarce, and urgently needed for the Triple Canal system. It is highly desirable that the capacities of the Lower Jhelum Canal system as well as those of the Lower Chenab Canal system should be thoroughly revised, so as to bring them more into accord with the Triple Canal system, with which they have to be worked sympathetically in rotation.

CHAPTER IV.

COLONIZATION.

CHAP. IV.

Colonization.

The gross area commanded by the canal is 1,368,398 acres, or 2,138 square miles. About three-quarters of this tract forms the up-land, or *Bar*, of the Doab ; and the area of Crown waste land available for colonization was 575,952 acres or 900 square miles. The rest of the commanded area consisted of land already occupied by private proprietors.

Concurrently with the commencement of construction in 1888-89 a geodetic survey of the entire commanded area was taken in hand. This involved laying out parallel lines, 1,100 feet apart, throughout the length of the Doab. Points fixed at 1,100 feet intervals along these lines formed the corners of squares of 1,100 feet or 200 *Karams*, side, into which the entire area was thus demarcated. Levels were obeserved at these corner-points and also midway between them, thus establishing the levels of ground surface at 550 feet intervals throughout the Doab as the basis of a contoured plan of the land. The alignments of the various channels were designed on the plan to follow the main, and subsidiary, watersheds of the country. The water-courses were designed to follow the sides and diagonals of squares and to deliver water to them at their highest points. The unit for colonization was the square of 27·78 acres ; and each colonist was required to subdivide each of his squares into 25 *Killas* or sub-squares, each of 220 feet side, or 1·11 acres, area.

A colonization officer was appointed, allotment of land to colonists was begun, and was carried on during the next few years, *pari passu* with the completion and bringing into operation of the various parts of the canal system. The colonization officer's annual reports, from 1902 onward, give full details of the soil survey and other preliminary work ; of the conditions of grants ; of the selection of colonists ; of the allotment of squares ; of all the many difficulties encountered and overcome, and of the progress of the colony from the beginning leading up to its present condition of prosperity.

Village planning.

Plate II is a plan of the lay-out of the *abadi*, or residential site, of one of the colony villages. Around the homestead is the village common, planted in part with trees. Sites have been reserved for the Post Office, school, way-farers' rest-house, *Patwar Khana*, or patwari's residence, and other public or general buildings.

Colonization.

In the table at Appendix B will be found the details of allotment at end of 1915-16. From it will be seen that 86 %

of the total area has been set aside for colonization; that 80% of the total is culturable and irrigable; 89% of the allotable area has been allotted and there is a balance of 11% to be allotted. Encouragement of horse-breeding formed one of the main features of the colonization, and allotments of land were made for this purpose. The details of the area allotted in the Shahpur District are as under:— CHAP. IV. Colonization.

		Acres.
To Horse-breeders	.. ..	210,905
To Private Stud Farm grantees	..	6,754
To Government Departments for remount, stud and seed farms	.. ..	33,549
To Aborigines or *Janglis*	.. ..	59,816
To Grants to headmen and menials	..	17,843
To Non-horse-breeders	.. ..	60,126
To Arboricultural operations	..	4,458
Occupied by towns, villages, &c.	..	11,440
Taken up for roads, canals and water-courses	.. .. ..	29,952
Total	..	434,843

Peasant colonists have proved to be the most successful and satisfactory tenants. They were selected from the agricultural classes, and were required to fulfil the horse-breeding conditions of the grant. Experience has shown that this class has been successful in horse-breeding. The same success has not attended the allotments made to Civil grantees. The failures have been chiefly among the non-resident colonists.

In the report of 1912 a very full summary of the results of the horse-breeding experiment was given. The operations made steady and encouraging progress down to 1907-08. In that year 5,317 mares were covered and 1,756 foals were born. Government purchased for the British and Indian cavalry 727 foals. There was a slight set back after that year, due, partly to a stiffening of the standard of purchases made by Government, and partly, it is said, to the colonists no longer considering their horse-breeding conditions as binding as they did prior to 1907-08. The average number of foals born during the five years following 1907-08 was 1,750, showing a small falling oft, but, later, there was an improvement in 1915-16, when 1918 were born. On the other hand the purchases made by Government have declined. In 1907-08 the number purchased was 727; this figure fell to 535 in the quinquennial period following to 438 in 1914-15, Horse-breeding.

CHAP. IV. — Colonization.

and to 294 in 1915-16. In the last year of report the decline was due mainly to the age limit having been raised from 9 to 12 months; the April and May foalings of the previous year being thus excluded from the field of selection. On the average the Colony has supplied Government with about 500 foals annually.

Area of cultivation. The cropped area of the colony has averaged 400,000 acres annually.

Population. In 1906 the population of the Colony stood at 73,734. This figure had risen to 161,806 at the regular decennial census of 1911, and was probably 250,000 by the end of 1917. Of the four principal towns of Phullarwan, Bhalwal, Sillanwali, and Sargodha, the last has a population of 9,000 and is fast growing. It is the head-quarters station of the Colony and of the Civil District. At Plate III will be found a plan of the town, showing the lay out of the occupied area and the positions reserved for future expansion.

Land values. Before the canal was projected there was no demand for the waste land in the *Bar* except as a safe place to drive stolen cattle into. Plots of land might have been secured at a merely nominal price. Concurrently with the first construction of the canal there was a rise in land values; and when the canal was opened the rise continued. The average market value of rural agricultural land is Rs. 200 per acre. But the price of small plots near towns and markets is very much higher. As early as 1909-10 the price of such plots was at the rate of Rs. 5,000 per acre at Sillanwali; and at Sargodha in 1916 a similar price was realised.



This illustrates what Government waste lands will look like when irrigation is developed in a few years time. This illustration speaks volumes.

CHAPTER V.

ESTABLISHMENT.

CHAP. V.

Establishment.

In the lower grades there are two separate classes of Establishment attending to the Engineering and to the Revenue work respectively. One set of subordinate engineer officials is required to keep the canal in efficient working order as an irrigating machine; while the other non-engineer set is concerned with the distribution of the water in irrigation, and with the assessment of the canal revenue. Higher up the scale are the Engineer Officers (Executive and Assistant) who supervise and control the operations of both classes of establishment; and in administrative charge of the whole canal, as an Irrigation Circle is a Superintending Engineer.

The Lower Jhelum Canal Circles.

The Lower Jhelum Canal Circle was constituted in 1898. In the statement at Appendix C will be found the names and periods of tenure of charge of the Circle of all past incumbents. The head-quarters was originally at Jhelum Cantonment, but in 1915 it was shifted to a more central position at Sargodha, the heart of the Colony. The Superintending Engineer is general manager of the Lower Jhelum Canal system, and his Circle includes also the Imperial and Provincial Inundation Canals which off-take from the Jhelum River in the Shahpur District. He controls the members of the canal establishment; arranging for their leave, postings and transfers; and the regulation and distribution of the available water supply throughout the year; and the allotment of funds. He has power to sanction estimates of the cost of works up to a certain limiting sums; and, under the authority of the Northern India Canal and Drainage Act of 1873, acts as a Court of Appeal from the decisions of his Divisional Officers in matters of assessment of revenue. The Lower Jhelum Canal Circle is divided into four divisions, each in charge of a separate Executive Engineer or Divisional Officer. A numerical list of the entire operating staff, with the exception of menials, will be found at Appendix D. The list does not include the establishment employed by the Superintending Engineer in his own office, nor those engaged in working the inundation canals in the Bhera and Shahpur Sub-Divisions of the Shahpur Division. These latter are one-season canals which off-take from the River Jhelum independently of the Lower Jhelum Canal, which is a two-season canal, perennially in flow.

The Rasul Division.

The Rasul Division, with head-quarters at Rasul, at the head of the Lower Jhelum Canal, comprises the river works at Rasul, 39·2 miles of the main canal, 34 miles of distributary channels, about 320 miles of water-courses, and 5·2 miles of

CHAP. V. Establishment.

drainage cuts and embankments. The area irrigated in this Division amounts to only about 38,000 acres annually, out of a gross commanded area of 68,000 acres. The Executive Engineer, or Divisional Officer, is in charge of the works which control the flow of the River and pass some or all of it into the canal at Rasul; and of those which subsequently distribute the flow at Fakirian, where the first main division of the water takes place. He has one Assistant, who is styled a Sub-Divisional Officer. There is a Railway 9 miles long, controlled by the canal officers which connects Rasul with Baha-ud-din Station on the North-Western Railway.

The Kirana Division.

The Kirana Division has its head-quarters at Sargodha. It comprises 4 Sub-Divisions and includes the whole of the Southern Branch of the Lower Jhelum Canal and all subsidiary channels taking off therefrom. The lengths of channels comprised in this Division are 28 miles of Branch Canals, 249 miles of Distributaries, 58 miles of Escape Channel, cuts and embankments, and about 2,420 miles of water-courses. The gross commanded area is 576,000 acres and the area irrigated annually about 392,000 acres.

The Sargodha Division.

The Sargodha Division has its head-quarters at Sargodha. It comprises 3 Sub-Divisions, and the Northern Branch Canal, and all its subsidiary chanrels, except the Sulki Branch, which irrigates the *Ara* tract. There are 71 miles of Branch Canals, 393 miles of Distributaries, 10 miles of Escapes and cuts, and about 2,940 miles of water-courses. The gross commanded area is 528,000 acres, and the annual irrigation about 284,000 acres.

The Shahpur Division.

The Shahpur Division, with head-quarters at Sargodha, has one Sub-Division of the Lower Jhelum Canal, *viz.*, the *Ara* Sub-Division, which consists of the Sulki Branch and all its subsidiary channels. There are 20 miles of Canal, 141 miles of Distributaries, 13 miles of Escapes and cuts and 927 miles of water-courses. The gross area is 177,000 acres, and the area irrigated annually about 83,000 acres. This Division includes also the Imperial and Provincial Inundation Canals on both sides of the river Jhelum in the Shahpur District. These latter canals are controlled by two Sub-Divisional Officers; *viz.*, by one in charge of the Shahpur Provincial Inundation Canals, with head-quarters at Bhera, and by another in charge of the Shahpur Imperial Inundation Canals with head-quarters at Shahpur.

Excluding the Rasul and Shahpur Divisions, where special conditions prevail, the average areas in the charge of each Executive Engineer are 552,000 acres gross, 338,000 acres of

which are irrigated annually. Each Sub-Divisional Officer has charge of 157,700 acres gross area, in which 96,500 acres are irrigated annually. A Zilladar's charge comprises 64,000 acres gross area, and 40,000 acres annual irrigation, and a Patwari's charge 6,300 acres gross area and 3,900 acres annual irrigation.

In the Rasul and Shahpur Divisions the figures are somewhat different, as shown by the following table :—

—	Rasul.		Shahpur.			
			Perennial.		*Inundation.*	
	Gross area.	Annual Irrigation.	Gross area.	Annual irrigation.	Gross. area.	Annual Irrigation.
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Executive Engineer ...	68,000	38,500	1,76,700 (+ Area on Ca-	83,000 Inundation nal.)	128,000 (+ Area on Ca-	61,000 Perennial nal.)
Sub-Divisional Officer ...	68,000	38,500	176,700	83,000	64,000	30,500
Zilladar	68,000	38,500	88,000	41,500	64,000	30,500
Patwari	6,170	3,500	7,000	3,300	5,500	2,600

The average expenditure in each division and sub-division is shown in Appendix D-1, whence it is calculated that the average annual expenditure per Division is Rs. 186,700, and, per sub-division, Rs. 66,500.

CHAPTER VI.

Maintenance and Repairs of Canal Works.

CHAP. VI.

Maintenance and repairs of Canal Works.

For the purpose of maintaining the canal system in good working order the Engineer has a staff of engineering subordinates, artizans and menials. At Appendix D will be found a numerical list of the subordinates who look after the Head-works on the river; 196 miles of Main Canal, Branches and Feeders; 997 miles of distributaries, and 42 miles of escapes, embankments, and diversion cuts, which are comprised in the Lower Jhelum Canal System. The average charge of a subordinate in charge of works is 31 miles of channel. Each of the 9 Sub-Divisional Officers of the circle has to supervise the work of 5 subordinates, on the average.

The river works at the head of the canal at Rasul are the most important works of the canal. Throughout the monsoon, and particularly during the passage of floods, the local engineers háve to be on the alert, and prepared to cope with sudden emergencies. Sometimes parts of the works are damaged by the floods, or changes take place in the volume and direction of the main stream; and it becomes necessary to adopt measures to retain control of the hydraulic regimé. When the river begins to fall, in the autumn, soundings are taken in the vicinity of all the works; and a hydraulic survey of the river, extending to a distance of a few miles up-stream and down-stream of the works is carried out. In the light of the results of this survey and of careful examinations of the condition of the works arrangements are made to carry out necessary repairs, alterations, or improvements during the ensuing winter or low-water season.

Rasul is connected by a railway belonging to the Canal Department with Baha-ud-din, a station on the Sind Sagar Branch Railway; and, through that railway, with the Baghanwala and Khewra building-stone and lime-stone quarries. The time available for carrying out repairs or alterations to works proves to be sometimes all too short, and is liable to be further curtailed by unforeseen freshets of the river. Consequently the engineer in charge of the Head-works is generally selected for the post by reason of constructional ability, resourcefulness and physical energy.

The masonry works through which surface drainage is passed across the canal are examined after the flood season to see if any repairs are necessary, and again just before the next monsoon, to make sure that they are in a fit state to carry off the drainage. The Lower Jhelum Canal has few works of this class.

Maintenance and repairs of Canal Works.

All earthen channels carrying water are liable to changes of cross section, or discharging capacity, resulting from erosion of, or deposit of silt on their bed or sides, or from the growth of weeds, or jungle. Their banks too are liable to be rutted by rainfall. In the larger channels fluctuations of water-surface levels, resulting from the changing nature of the demand for water, sometimes cause the sides to slip. Distributaries which at one time of the year may be supplying water proportionately to all outlets throughout their courses may at other times be found to have lost efficiency in this respect. The beds of channels can only be examined thoroughly when the water is shut off. The bed of the main canal can only be examined at rare intervals, when the canal is shut at its Head. The smaller channels are more frequently closed and can be more frequently examined. From time to time it becomes necessary to remodel the design of branch canals or distributaries as to alignment, gradient, or capacity. Hydraulics is an empirical science; its secrets and surprises are endless; and there is never any lack of scope for engineering skill in the control and working of an irrigating canal system.

Almost all work of construction or repairs is executed as piece-work, or by petty contract, or by labourers paid daily wages. On occasions of emergency the canal officers may demand the supply of labour by the irrigating community, as, for instance, when the water flowing in the canal breaches its banks, or when it becomes necessary to execute rapidly any work on which the irrigating efficiency of the canal depends. The people usually turn out willingly enough, if they realize that the execution of the work is bound up with their own interests.

The Superintending Engineer and the Executive Engineers of the Canal have certain definite powers of sanctioning expenditure. In the table following will be found the limits of powers to sanction expenditure which have been entrusted to these officers, subject to the provision sanctioned in the departmental budget for the year:—

Heads of Account.	Superintending Engineer's powers.	Executive Engineer's powers when in charge of a Division.
Maintenance and Repairs ...	Up to limit of sanctioned Budget.	From Rs. 200 to Rs. 2,500.
Extensions and Improvements ..	From Rs. 5,000 to Rs. 10,000	From Rs. 200 to Rs. 2,500.
Establishment	Rs. 100	Work charged.
Tools and Plant	From Rs. 2,500 to Rs. 5,000 ...	Rs. 500.
Suspense	Full powers	*Nil.*
Taccavi works	Up to Rs. 10,000... ...	Rs. 200.

CHAP. VI.

Maintenance and repairs of Canal Works.

In the case of urgent repairs estimated to cost a sum in excess of his powers of sanction, and when serious consequence might follow any delay, the Executive Engineer is empowered to start work in anticipation of sanction, under certain well defined rules.

The average annual expenditure on the working of the Lower Jhelum Canal amounts to about 10 lakhs of rupees.

CHAPTER VII.

THE CONTROL AND DISTRIBUTION OF CANAL WATER.

The regulation of the water supply at the head of the canal is rendered difficult by the great variations in the volume of flow of the parent river, the said variations ranging from about four thousand to about six hundred thousand cusecs.

CHAP. VII.

The control and distribution of Canal water.

The difficulty is increased by the great proportion of sand and silt borne by the river currents, especially in the summer, or flood season. It is the business of the Officer controlling the supply at the head of the canal to ensure that the flow of water from the river to the canal is not obstructed by shoals, and that the flow does not carry an excess of sand or detritus into the canal.

A reprint of the rules and regulations for the management of the Head Works of the canal at Rasul will be found in Appendix E. The rules require that during the flood seasons an Engineer Officer, that is, either the Executive Engineer or the Sub-Divisional Officer in charge of the Head Works, should always be present at Rasul to supervise the regulation of the water supply.

The main considerations of water control at canal head are :—

(1) to meet the demands for water-supply for the whole canal system ;

(2) to ensure the safety of the works ;

(3) to prevent excessive quantities of coarse silt or sand entering the canal ;

(4) to ensure an uninterrupted flow of water from the river into the canal whenever it is required.

The regulations lay down instructions for the guidance of the canal officers at canal heads on the occurrence of flood in the rivers.

There are Water Gauge Stations established on the River Jhelum at Jhelum, Mangla, and Kohala, places respectively 20, 40 and 90 miles upstream of the canal head at Rasul. These are connected by telegraph with Rasul, with a view to warning the canal head officers of the approach of floods. In spite of such warnings, however, it occasionally happens that a flood, due to rainfall on the hill catchments in the vicinity of Rasul, arrives unexpectedly at the canal head-works, and then the canal head officer has to rely on his own judgment and resourcefulness in dealing with the situation.

CHAP. VII.

The control and distribution of Canal water.

River floods occur most often during the summer and autumn; but floods of considerable magnitude are also liable to occur sometimes during the winter, and may then be a source of peculiar danger on account of the fact that repairs and alterations to the canal head-works are often in progress during the winter, and the water-way of the river is sometimes artificially obstructed in consequence of these operations.

The demand for water on the canal system is also liable to great variations, in consequence of variations in the irrigation demand, resulting from rainfall or other seasonal vicissitudes; and these variations of demand have to be met by variations of water supply at canal head.

Breaches of the earthen embankments of the canal, due either to accidental leakage, or over-flow, of the water in the canal, or to deliberate cutting of the banks by local land-owners, have also to be reckoned with. If such a breach occurs in a channel of considerable magnitude, with water to the extent of say, 1,000 cusecs, flowing through the breach, it may be extremely difficult to close the breach without first arranging to shut off, or partially reduce, the volume of water flowing down the canal. A breach may occur, say near Sargodha, about 75 miles distant from the canal head at Rasul. A reduction of water supply at Rasul, ordered by telegraph from Sargodha, could not take effect at Sargodha until after the lapse of at least 37 hours; as the mean velocity of flow of the canal is about two miles an hour. One thousand cusecs could irrigate at least 6,000 acres in 37 hours; and this rough calculation affords some idea of the economic loss to agriculture that may result from any delay in the closing of a canal breach, even with a perfect system of control by canal telegraph.

The Lower Jhelum Canal has a system of telegraph lines with telegraph stations located about 20 to 30 miles apart all over the tract irrigated by it. As prompt action in the closing of breaches is essential to prevent a waste of water of high commerical value, the rules for regulation of supply give authority to any canal official, even a subordinate official, to order a closure, or reduction of supply of the canal in the event of a breach of great magnitude.

The completion of the Triple Canal System, during the period 1904—1915, has complicated the control of water supply at the head of the Lower Jhelum Canal, by reason of the fact that the Triple Canal System now shares with the Lower Jhelum Canal the water supply of the river Jhelum in the cold weather.

CHAP. VII.

The control and distribution of Canal water.

In Appendix G will be found a reprint of the rules according to which the waters of the Jhelum, Chenab and Ravi Rivers are distributed among between the Lower Chenab Canal, the Lower Jhelum Canal and the Triple Canal System.

The Superintending Engineer, Lower Jhelum Canal, watches the general distribution of water supply in his daily telegraphic water account, in order to see if his canal is receiving its appropriate share. The Divisional Officers under him, in the same way, study their daily water accounts in order that each Divisional Officer may see that his own Division is receiving its proper share of supply ; and in the same way also the Sub-Divisional Officers study their water accounts in the interests of their own respective Sub-Divisions.

When the supply of water delivered to the canal at its head is less than its authorised full supply ; that is to say, less than the aggregate requirements of the various branches of the canal system ; instead of giving each branch a proportional share of the total available supply in continuous flow, it is customary to give each branch its *full supply* for a *restricted period of time*, and then to *close* it while other branches are given a full supply for appropriate periods of time.

Experience has shown that this rotational method of distribution of water supply is more economical than the continuous flow method ; or, at any rate, more efficient.

The demand for water supply in the canal is arrived at by ascertaining the wants of individual irrigators throughout the canal system. The Canal *Patwari,* who ranks lowest amongst canal revenue officials, ascertains the demand for the few villages under his control, and presents it to his superior officer, the *Zilladar,* periodically. The Canal *Zilladar* collects the demands presented by the *Patwaris* under his control, and presents the aggregate result, for each distributary of the canal system within his charge, to the Sub-Divisional Officer. The Sub-Divisional Officer similarly collects the demands of his *Zilladars* and presents the aggregate demands for his Sub-Divisions to his Divisional Officer, or to the next Sub-Divisional Officer of the canal in the upstream direction ; and finally the Officer in charge of the Division at the head of the canal admits water into the canal in accordance with the aggregate demand of all the Divisional Officers including himself.

All important variations in demand throughout the canal system are communicated by telegraph to the Canal Head Officer, who regulates the volume of flow admitted into the canal, accordingly. In addition to the canal telegraph system, there is a

CHAP. VII. — The control and distribution of Canal water.

canal postal system, carried on by dâk runners, or foot-messengers, who are supposed to run, but more usually walk, from rest house to rest house, along the main canal routes, in order to convey to each canal officer or subordinate, official correspondence, business documents, &c.

For the control of water supply throughout the canal system it is necessary to maintain water-gauges at suitable points along the main and branch canals ; and at the head, and often at the tail, also, of each distributary. The readings of the water surface level at these gauges are recorded daily, and sometimes twice or three times a day, at each gauge site ; and the results are recorded by each local gauge-writer in a register kept for the purpose. The gauge-writer sends up a slip, containing his daily record of gauge readings to the Sub-Divisional Officer ; who, again, records them in a register maintained by himself. The Divisional Officer also maintains a register of the daily gauge readings of all the Government water-channels under his care ; and, wherever the saving of time renders it advisable, the daily gauge-readings of water-channels are communicated to the Divisional and Sub-Divisional Officers by telegram. The Superintending Engineer also maintains a register of daily gauge readings of the main canal and of the principal branch canals and distributaries ; the said readings being communicated to him by telegram daily.

CHAPTER VIII.

Assessment of Revenue.

CHAP. VIII.

Assessment of Revenue.

The assessment of the water revenue of the Canal is made through the agency of the Canal Revenue Staff working under the orders of the Executive Engineer. It is done twice a year, once for each agricultural season, known as the Kharif and Rabi seasons respectively. The revenue is subsequently collected by the agency of the civil revenue authorities, under the orders of the Deputy Commissioner of each district.

A numerical list of the staff engaged for the assessment of canal revenue derived from the area of 800,000 acres, or so, annually irrigated by the Lower Jhelum Canal, will be found at Appendix D. On the average one *Patwari* is in charge of the canal revenue work of a gross commanded area of 10 square miles, within which about 4,200 acres are irrigated annually; one *Zilladar* supervises the work of about 10 *Patwaris ;* and one Assistant Engineer or Sub-Divisional Officer controls the operations of two or three *Zilladars.* The Canal Deputy Collector exercises magisterial powers, supervises the work of the *Patwaris* and *Zilladars,* and is the Executive Engineer's Revenue Assistant.

The system of canal assessment work may be described briefly as follows :—During the currency of each agricultural season a register called the *Shudkar-Khasrah* is maintained by the Canal *Patwari,* in which is recorded the distinguishing number of each field that is irrigated, as soon as possible after the first application of water to the field. The *Patwari* records also any cases of illicit irrigation, waste of water, &c., which may come to his notice. About the time when the crop is coming to maturity, particulars of all irrigated fields are finally recorded in the *Shudkar-Khasrah* in columns set apart for the purpose, measurements of the dimensions of the space irrigated in each field are recorded in cases where this may be found necessary, *i.e.*, in cases where the area is not deducible from existing records. A *parcha,* or slip of paper, is delivered to each cultivator, showing the area of each field which is liable to water-rate as having been irrigated ; and what he will be required to pay in due course.

An irrigator may raise objections to the revenue demand, and if so the Canal Department has to investigate the facts and deal with the objection before the crop concerned is harvested. The Canal authorities arrange to remit the water charges on crops which have failed to come up to a recognized standard of maturity, and inform each cultivator in writing of the remissions which have been granted to him.

The assessment papers are corrected accordingly, and then sent to the Deputy Commissioners of the districts, for realization of the revenue.

At Appendix H will be found a schedule of water rates authorised for the Lower Jhelum Canal. The revenue is collected from the irrigators by the *Lambardars*, or Headmen, of each village; who receive a remuneration amounting to three per cent. of the collections, for this duty. These *Lambardars* are expected to attend the Canal *Patwari* during his final registration of irrigation; and also to attend any other Canal Revenue Officer who may require his assistance in connection with irrigation business; if he fail in his duty in any of these respects he is liable to lose the whole, or a part, of his remuneration, under the orders of the Divisional Canal Officer.

A Canal *Patwari* is placed in charge of a circle consisting of several villages, comprising a gross area of about 5,000 acres. The size of his charge is regulated so as to comprise about 4,000 acres of irrigation, annually, in proprietary village land, or about 5,000 acres of irrigation annually in Crown colonies. He is expected to record in his *Shudkar*, or initial register of irrigation, the number of each field which is irrigated, as soon as possible after irrigation is applied to it. Later on, when the crop is approaching maturity, he has to make a more precise and final register of all fields which have been irrigated during the current agricultural season. The register in which he ascribes the initial record, as well as the final record of irrigation, is known as the *Shudkar Khasrah*. From the data of final measurements, the demand due from each irrigator is calculated, and placed on record in the *Khatauni*, or Demand Statement.

After preparation of the *Khatauni*, a slip is supplied to each irrigator, in which is entered a copy of his water-bill, extracted from the *Khatauni*.

The *Patwari* is expected to report to higher authority matters of interest to the canal administration which may come to his notice during his field inspections; such as accidents to works, sufficiency, or otherwise, of supply, damage to crops from insects, seasonal visitations, etc. The salary of the *Patwari* is fixed at Rs. 10 per mensem, and he is entitled also to a further remuneration, which amounts, on the average, to about Rs. 5 per mensem, but varies with the quality of his work.

A Canal *Zilladar* has generally about 10 *Patwaris* employed under him; and his principal duty lies in checking and supervising their work. He is required to investigate all cases reported of

unauthorised irrigation, waste of water, disputed charges, or objections to assessment, etc., etc.

In certain estates, the water supply of which is considered both by the Deputy Commissioner and by the Divisional Canal Officer, to be precarious, or unsatisfactory, the *Zilladar* has to inspect every irrigated field, and to make a record, of the condition of the crop in each field, the crop of which has wholly, or partially, failed to arrive at a certain recognized standard of maturity. The rules regarding the remission of revenue on failed crops are contained in Rule 20, under Section 22 of the Canal Act.

The Canal Deputy Collector attached to each Canal Division supervises and checks the work of all the *Patwaris* and *Zilladars* in the Division, and is his Divisional Officer's chief advisor in revenue matters. He is the head of the vernacular section of the Divisional Office, and performs most of the magisterial work of the Division.

The Canal Sub-Divisional Officer, and the Canal Divisional Officer, supervise the work of the whole of the Revenue establishment of the Sub-Division, and Division, respectively, in connection with the registration of all irrigation. Each officer is expected to inspect personally a certain proportion of the entire area irrigated, and to ascertain whether each field inspected has, or has not, been irrigated, and what the condition of its crops is.

The Divisional Canal Officer is the Chief Executive Officer, in charge of a section of a canal system termed a division, and he is responsible for its entire management.

CHAPTER IX.

General considerations.

CHAP. IX.

General considerations.

Throughout the tract irrigated by the Lower Jhelum Canal the natural drainage lines have been demarcated on the ground, and a definite width along each such line has been reserved by the State for any projects of drainage which may be found necessary in the future. Partly with a view to equalize distribution of supply, and to limit liability to the carrying capacity of the canal system, and partly in order to reduce the risk of water-logging low-lying riverain lands, it has been arranged to irrigate annually only 75 per cent of the culturable area in any given locality in the *Bar*, or uplands, and only 40 per cent. in the low-lying riverain lands. For the encouragement of colonization the 40 per cent limit has been waived in the riverain lands taken up by colonists, and this limit is applied only to proprietary village lands in the riverain tracts.

Throughout the Jhech Doab lines have been drawn on the map roughly parallel to each other, and at right angles to the general alignments of the Jhelum and Chenab Rivers, at intervals of about six miles from each other; and along these lines existing wells have been selected, at intervals of about five miles apart. All these wells are distinctively numbered, and the level of the spring water in each is measured, observed and recorded twice a year, *viz.*, in the months of June and October; and the results observed are recorded in registers. These statistical data keep the canal engineers informed of the periodical variations of the levels of the subsoil water table, and of the effect thereon of rain-fall and of percolation from the earthen channels of the canal system.

Executive Engineer or Divisional Officers, and their Assistants or Sub-Divisional Officers, and Deputy Collectors are invested with magisterial powers for the punishment of offences against the Canal Act. During the five years ending 1919-20 the officers of the Lower Jhelum Canal who possessed magisterial powers had 221 cases brought before them, *vide* Appendix I, of which 115 were settled out of Court. The Executive Engineer directs and controls the institution of such cases; and appeals from the decisions of canal magistrates lie to the Collectors, or Deputy Commissioners, of districts.

On the Lower Jhelum Canal System mills have been built at four sites, *vide* Appendix J. They have paid good returns on the outlay in the past. The mills have been built by the State and are leased out at rates of so much per stone per diem.

The leases are put up to auction annually and the contractor whose bid is accepted is put in possession of the mills early in April. The rents are collected monthly under the orders of the Executive Engineer by the Sub-Divisional Officer and the amount is credited in the Canal accounts under the heading Miscellaneous Receipts.

All water rate revenue due on account of irrigation is collected for the Canal Department by the civil authorities of the Districts concerned. Charges for water used in other ways than in irrigation are collected by the agency of the Canal Department itself. Small sums due for water used in making bricks, concrete or masonry construction, etc., are collected by the Canal *Zilladar* who keeps a Cash Receipt Account and pays the sums collected to the Sub-Divisional Officer's cash chest at suitable intervals. Larger sums due for grazing leases, or mill rents, or for water sold in bulk for filling tanks are received by the Sub-Divisional Officers. Other items of miscellaneous revenue are accounted for by book transfers by the Divisional Officer and are shown in the Accounts of the Division. The miscellaneous receipts from all sources are shown in detail by the Accountant-General in a special form of account.

Municipal Committees have been set up in the townships of Sahiwal, Sargodha, Bhera and Miani. There are also three Notified Areas, *viz.*, Bhalwal, Phullarwan and Sillanwali. The distinction between a Municipal Area and a Notified Area is that the former is an area comprising at least one town or bazar of not less than ten thousand inhabitants, while the latter must contain a town or bazaar, must not be a purely agricultural village, and must not contain more than ten thousand inhabitants.

There are 11 Canal Hospitals or Dispensaries within the limits of the tract irrigated by the Lower Jhelum Canal. These were originally established and maintained by the Irrigation Branch. To avoid duplication of institutions, and to meet the growing wants of the colonists, five of these have been taken over and managed by Municipal Committees, five others are made more useful by contributions from the District Board, amounting to Rs. 320 per annum for each Dispensary, and only one now remains a Canal Dispensary, pure and simple. Besides these there are the Police Hospital at Sargodha, maintained by Government; and Female Hospitals at Bhera and Sargodha, maintained by Christian Missions. The figures of 1914 show that 4,300 in-door and 218,874 out-door patients were treated at these

CHAP. IX. — General considerations.

medical institutions. At that time this represented a proportion of one patient treated out of about every three persons of the entire population.

As the canal progressed roads were laid out along the Main Channel, Branches and Distributaries. Later on, when the colonists arrived village and district roads were laid out. Still later, when the Railway was carried through the tract, feeder roads were made from towns to railway stations. Most of these are unmetalled. There are, however, four metalled roads, *viz.*, from Sargodha to Sahiwal, to Shahpur, to Bhagatanwala, and to Lak, respectively.

The Jhech Doab Branch of the North-Western Railway passes through the entire length of the colony, roughly parallel to and close alongside the Main Canal. This Railway has proved a profitable State investment and has done much towards developing the prosperity of colony.

Markets, or *Mandis,* have been established at certain railway stations, such as Phullarwan, Bhalwal, Sargodha, Sillanwali and Shahjiwana. These marts have been built to facilitate the export of agricultural produce, and are managed by Committees of *Chowdhris.* The Agents of European Export merchants purchase the produce from traders, middlemen and cultivators, and despatch their purchases to Karachi or Bomaby for export.

Under the auspices of the Agricultural Department a Seed Farm of 170 acres in extent was established in the early days of the colony near Sargodha, and managed by a Superintendent. Considerable quantities of good seed have been grown, year by year, for distribution and for sale to the cultivators. In connection with this business there are many and varied agricultural implements in use in the Farm, and demonstrations of their use are given by an Instructor to *Zamindars* or land-holders. The farm has served a very useful purpose in agricultural development and in the production of improved qualities of cotton and cereals.

The majority of the colonists on the Lower Jhelum Canal, both civil and military, are required by the terms of their grants to keep one, or more, mares for breeding young stock, according to the size of grant (one mare for every 1½, or 2, squares according to the terms of the grant) and to replace within three months any mare which may have died or ceased to produce. The entire management of the business of providing Government

stallions, branding and registering the mares, and purchasing the young stock, on which Government has a lien, is done by the Army Remount Department.

CHAP. IX.

General considerations.

There are in the colony area two Remount Depôts, at Mona, and Sargodha, respectively, which cover extensive areas and are managed by British Officers of Indian Cavalry Regiments. Each is in charge of a Superintendent and Assistants helped by Veterinary and Medical Officers. The purpose of those Depôts is to receive the young country-bred horses and mules from all the districts in the United Provinces, Punjab and Baluchistan where such stock is reared. The usual complement of animals is 1,500 horses and 1,400 mules, but these numbers were considerably exceeded during the Great War. By farming portions of the reserved areas the Depôts have been able to earn money sufficient to render them practically self-supporting.

Such stunted jungle growth as existed in the Jhech Doab prior to the construction of the canal, which served no useful purpose except as a source of fuel, has been almost entirely done away with in the process of bringing the land into use for agriculture; and for the purpose of providing a supply of fuel as well as for the sake of shade avenues of trees are grown along the banks of the main and branch canals and plantation. Trees, generally Shisham and Kikar, are grown along strips of land on each side of the larger channels.

These plantations are worked by the Canal Department and are for the most part assisted by irrigation from the canal, though this is not possible where the plantation is on top of a spoil bank composed of earth dug out of the canal.

On the Lower Jhelum Canal there are some 1,775 acres of such plantation, and about 1,100 miles of avenues along inspection roads.

CHAPTER X.

STATISTICS.

CHAP. X.
Statistics.

In common with the other great canals of the Punjab, the Lower Jhelum Canal is classed as a Productive Work; that is to say, the revenues from the sale of water show a profit to the State after defraying all working expenses and paying interest on the capital raised for its construction.

The position of the canal as a revenue-earning machine is reviewed annually in the Administration Report of the Irrigation Department; from which report, for the financial year 1917-18, the figures given below have been taken.

Down to the end of that year the total capital expenditure on the Lower Jhelum Canal amounted to Rs. 1,62,25,129. The net revenue from all sources in that year amounted to Rs. 29,68,548, after deducting interest charges on the capital expended, so that the net percentage profit on capital amounted to no less than 18·29 per cent.

It may be explained that the revenues of the canal system are classified into Direct Receipts and Indirect Receipts. Of these the Direct Receipts are sums realized by the sale of water for irrigation, or miscellaneous use, and sums obtained by the sale of the canal produce, such as fuel, timber and grazing rights. In the year under consideration these receipts amounted to Rs. 27,90,791.

Indirect Receipts which are credited to the Canal comprise that portion of the land revenue which is considered to have accrued by reason of the construction of the canal; that is to say, the difference between the land revenue which could be imposed on the land in its unirrigated aspect, and that which is actually levied on the irrigated land. In this category is also included a book credit on account of interest on the amount realized by the sale of Government waste lands, which, but for the canal, would be valueless, but a deduction is made to cover the increase in cost of Civil Administration which the development of the district necessitates. These sums, which are rightly considered as part of the profit of the canal, amounted in 1917-18 to Rs. 16,38,652, so that the gross receipts of both Direct and Indirect Revenue, amounted to Rs. 44,29,443, while the total charges to revenue, *i.e.*, working expenses, etc., amounted to Rs. 9,15,765, leaving a net profit, before deducting interest on capital, which is the true profit in a commercial sense, of Rs. 35,13,934, or 21·65 per cent on the capital expended.

During the same year the area of crops irrigated amounted to 765,470 acres, out of which water rates were charged on 752,190 acres, remissions of revenue having been granted on the difference of 13,280 acres on account of the crops having failed to mature for reasons not in the control of the cultivators. **CHAP. X. Statistics.**

Statistical statements giving all the leading features of the canal, rates charged for the supply of water from it, and statements of accounts of receipts and expenditure, illustrated by diagrams of the results, are included in the Annual Administration Report and need not be repeated here.

In another important annual publicaton, "Statistics of Irrigation, Water Distribution and Working of Distributaries of Canals in the Punjab" are collected every year statistics of a more technical character. In this compilation will be found details of areas irrigated in each crop arranged by tahsils and civil districts.

Statements are also given showing the areas of land commanded, culturable, irrigable and irrigated in each crop on every separate distributary. The authorized discharge of each distributary is given, as also is the number of acres in each crop which were irrigated per unit of discharge and the average depth of water applied to the fields in each crop. Details of the working of Main and Branch Canals, Water-consumption Diagrams, and statistics of rainfall, are also included in this volume, which is of great value to the Canal Engineer, enabling him, by comparing the efficiency of distributary with distributary, to detect and remove defects in design or maintenance; while at the same time these statistics supply data of the utmost value for the purpose of designing other canals.

On the Lower Jhelum Canal the gross area of land commanded amounts to 1,368,398 acres, out of which 205,933 acres are classed as unculturable; while, of the remainder, 568,921 acres are intended to be irrigated annually, $\frac{2}{3}$ in Rabi and $\frac{1}{3}$ in Kharif. Actually, in 1917-18 an area of 765,470 acres was irrigated, of which 533,598 acres was in Rabi and the balance in Kharif.

In that year, each cusec of water flowing continuously at the canal head irrigated 91 acres of Kharif crops, and 179 acres of Rabi crops; and the average water rate charged in each crop amounted to Rs. 3·46 per acre.

Glossary of Vernacular and Technical Terms.

Abadi .. Village dwellings, homestead.

Bar .. The high-lying watershed, or uplands, between two rivers.

Chaharami dues .. A share of the produce of the land payable in kind by the cultivator to the proprietor. Literally a fourth part, but varying in practice.

Commanded Land .. Land which can be irrigated from a canal by direct gravitation flow.

Colonization Officer .. The Civil Officer in charge of the colonization of Government Waste Land in a Colony.

Delta .. Sometimes denoted by $\triangle$. A term used to describe the quotient of the total cubic contents of water flowing through a canal in a given period of time, divided by the area irrigated (acres) by the said volume of water.

Doab .. Literally "two waters." The land enclosed between two rivers in the Punjab Plains.

Duty .. The area in acres which is irrigated by one cusec flowing constantly through an agricultural season or year. It is the quotient of the area irrigated by a canal in a given period divided by the average discharge of the canal during the period in cubic feet.

Escape .. A channel with a regulator at its head through which surplus water can be passed out of a canal. A safety valve to the Canal.

Headworks .. The collective name for all structures and works in a river for the purpose of taking a canal off from it.

Hithar .. Low lying riverain lands, situated between the *Bar* and the river, formed by comparatively recent alluvial deposit from floods.

Inundation Canal .. A canal taking off from a river without any means of raising the water level of the river of Canal Head so as to feed the Canal at seasons of low water. Water can enter such a canal only during period of high river, which in the Punjab is roughly from April to September.

Jhech Doab	..	The *doab* between the Jhelum and Chenab rivers.
Jagir	..	An assignment of Land Revenue from a specified plot of land.
Karam (*Kadam*)	..	(Lit. a pace, or double pace). A measure of length, generally 5½ feet, but varying in different districts.
Kharif	..	The summer agricultural season extending generally from April to September. Some Kharif crops are, however, sown before 1st April, and others harvested after 30th September.
Khadir	..	See *Hithar*.
Lakh	..	One hundred thousand.
Nahri	..	Canal-irrigated.
Nakka	..	A ledge of land at a level intermediate between that of the *Bar* and that of the *Hithar*.
Nala or *Nallah*	..	A natural water channel, generally dry, but often carrying a large volume of water after rainfall.
Outlet	..	The orifice in a distributary bank through which water is supplied to a watercourse.
Patwari	..	The subordinate canal revenue official who records the fact of irrigation of each field, and prepares the accounts of assessment of revenue thereon. The functions of a Civil *Patwari* are different.
Patwar Khana	..	The *patwari's* headquarter residence.
Perennial Canal	..	A canal having permanent control of the river at its head and capable of flowing throughout the year.
Rabi	..	The winter season from 1st October to 31st March. Some rabi crops are, however, irrigated or sown before 1st October, and harvested after 31st March.
Rechna Doab	..	The *doab* between the Ravi and Chenab rivers.
Silt Berm	..	A deposit of silt at the sides of a canal.

Soil Survey	.. A survey of a tract of country for the purpose of mapping it out into plots and classifying the quality of the soil in each plot.
Spring Level	.. The level at which water stands in a well. The level of the subsoil water table.
Taccavi work	.. Work carried out by Government agency on behalf of a private individual or co-operation who pays the cost thereof.
Watercourse	.. The term applied to the small water channels owned and maintained by the cultivators, which deliver water into the fields.
Work charged Establishment.	Establishment employed on a specific work whose pay is provided for in the estimate of the cost of that work.

APPENDIX A (1).

Capital cost of the Lower Jhelum Canal on 31st March 1917 when the Capital Account was closed.

Main Heads.	Sub-heads.	Amounts of Sub-heads.	Total.
		Rs.	Rs.
A.—DIRECT CHARGES.			
I.—Works	(1) Head works ...	31,93,134	
	(2) Main Canal and Branches.	57,43,673	
	(3) Distributaries ...	36,45,696	
	(4) Drainage and Protection works.	91 990	
			1,26,74,493
II.—Establishment	...	...	21,90,858
III.—Tools and Plant	...	...	3,62,956
IV.—Suspense	...	...	3.77,749
			1,56,06,056
V.—Less receipts on Capital Account	...	...	– 62,609
Total Direct charges ...			1,55,43,447
B.—INDIRECT CHARGES.			
(23) Capitalization of abatement of Land evenue.	...	...	83,000
(25) Leave and pension allowances ..	...	...	3,06,721
Total Indirect charges ...	...	..	3,89,721
Total Direct and Indirect charges.	...	...	1,59,33,168
Accumulated simple interest ...	...	...	83,63,714

APPENDIX A (2).

Statement showing growth of Irrigated area and Revenue, Lower Jhelum Canal.

Year.	Irrigated area.			Area on which collections were made.	Water-rate revenue.		Total revenue from all sources.
	Total.	Remissions.	Percentage of remissions.		Amount.	Rate per acre.	
1	2	3	4	5	6	7	8
	Acres.	Acres.		Acres.	Rs.	Rs. A. P.	Rs.
1901-02 ...	65,367	...	...	65,367	...	...	...
1902-03 ...	138,911	...	...	138,911	16,064	0 2 0	37,810
1903-04 ...	279,260	...	...	279,260	2,72,601	1 0 0	2,23,065
1904-05 ...	305,900	...	...	305,900	4,62,393	1 8 0	4,85,906
1905-06 ...	446,659	...	...	446,659	7,62,247	1 12 0	8,60,435
1906-07 ...	676,234	241,151	36	435,083	13,32,238	3 0 0	16,26,326
1907-08 ...	655,577	112,048	17	543,529	13,35,518	2 8 0	16,81,543
1908-09 ...	711,619	93,923	13	617,696	18,99,788	3 1 0	23,13,269
1909-10 ...	731,465	91,302	12	640,163	20,59,835	3 4 0	25,07,140
1910-11 ...	746,446	72,119	9	674,327	22,76,147	3 6 0	28,06,989
1911-12 ...	799,649	102,154	13	697,495	22,34,007	3 3 0	27,63,711
1912-13 ...	804,361	20,716	2·5	783,645	26,30,725	3 5 0	42,19,176
1913-14 ...	823,532	20,313	2·4	803,219	27,05,178	3 5 0	43,04,154
1914-15 ...	821,488	21,687	2·6	799,801	27,43,383	3 7 0	43,64,474
1915-16 ...	834,176	22,280	2·7	811,896	25,80,563	3 3 0	41,21,783
1916-17 ...	804,761	8,477	1·05	796,284	29,10,119	3 11 0	47,38,593
1917-18 ...	765,470	13,748	1·80	751,722	27,32,635	3 10 0	44,29,159
1918-19 ...	777,496	10,577	1·36	766,919	26,17,[illegible]74	3 7 0	42,77,101

APPENDIX B.

Statement of Colonization Allotment, 1915-16.

District.	Section of Canal.	Total area of Crown waste.	Allotable area.	Culturable and irrigable portion of area in column 3.	ALLOTTED AREA.		Balance unallotted.	REMARKS.
					Total.	Cultivated.		
1	2	3	4	5	6	7	8	9
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	
Shahpur ...	Main Line	33,664	29,000	27,174	26,392	25,089	2,608	Allotable area 80 per cent of total, of this 89 per cent allotted and 11 per cent remains to be allotted.
	Northern Branch ...	278,261	230,000	223,815	210,627	189,525	19,373	
	Southern Do. ...	236,831	220,000	199,077	197,824	176,943	22,176	
	Total ...	548,756	479,000	450,066	434,843	391,557	44,157	
Jhang ...	Khadir Distributary ...	2,912	2,236	2,692	708	708	1,528	
	Messan Ditto ...	24,284	18,946	22,903	8,307	8,307	10,639	
	Total ...	27,196	21,182	25,595	9,015	9,015	12,167	
	GRAND TOTAL ...	575,952	500,182	475,661	443,858	400,572	56,324	

APPENDIX C.

List of Superintending Engineers, Lower Jhelum Circle.

Name of Officer.	Period of Incumbency.		Remarks.
	From	To	
Mr. Sidney Preston	15th October 1898 ...	24th December 1898.	
Mr. G. M. R. Field	24th December 1898	9th July 1900.	
Mr. H. J. Johnston	9th July 1900 ...	10th October 1900.	
Mr. G. M. R. Field	10th October 1900 ...	31st October 1901.	
Mr. H. J. Johnston	31st October 1901 ...	16th November 1901.	
M. J. J. Mullaly	16th November 1901	10th June 1903.	
Mr. J. T. Farrant	10th June 1903 ...	14th March 1905.	
Mr. H. V. S. Baker	14th March 1905 ...	5th May 1906.	
Mr. R. H. Tickell	5th May 1906 ...	24th April 1907.	
Mr. H. V. S. Baker	24th April 1907 ...	19th October 1909.	
Mr. H. F. B. Frost	19th October 1909 ...	11th September 1911.	
Mr. C. J. Floyd	11th September 1911	23rd October 1911.	
Mr. H. F. B. Frost	23rd October 1911 ...	21st May 1912.	
Mr. C. B. Williams	21st May 1912 ...	6th November 1913.	
Mr. F. W. Schönemann ...	6th November 1913 ..	6th July 1916.	
Mr. R. Cannell	6th July 1916 ...	14th October 1916.	
Mr. F. W. Woods	14th October1916 ...	27th December 1916.	
Mr. I. D. E. Hughes	27th December 1916	9th January 1917.	
Mr. J. W. Gillmon ...	9th January 1917 ...	7th May 1917.	
Mr. W. P. Sangster, C.I.E. ...	7th May 1917 ...	To date ...	The present incumbent.

APPENDIX D.

Numerical strength of Establishment employed on the Lower Jhelum Canal.

Name of Division.	Head-quarters at	Number of Sub-Divisions.	Superior Staff.		Work Staff.			Revenue Staff.				Office Staff.		Regulating Staff.		Auxiliary Staff.			
								Field operators.			Office Staff.								
			Executive Engineers.	Sub-Divisional Officer	Engineering Subordinates.	Mistris and artificers.	Cashiers and Storekeepers.	Deputy Collectors.	Zilladars.	Patwaris.	Munshis and Amins.	Accountant and Clerks.	Draftsmen and Tracers.	Gauge Readers.	Jamadars and Beldars.	Telegraph Operators.	Assistant and Sub-Assistant Surgeons.	Treasure Guards.	Peons and Khalasies, &c.
Circle Office	Sargodha	...	1 S.E.	...	...	...	...	...	...	...	...	11	3	...	...	...	...	...	8
Rasul ...	Rasul ...	1	1	1	10	6	1	...	1	13	5	12	6	10	34	9	1	7	34
Kirana ...	Sargodha	4	1	4	16	4	...	1	9	94	23	13	4	41	23	11	3	20	49
Sargodha ...	Do.	4	1	4	18	4	2	1	8	77	20	13	10	32	27	11	2	20	57
Shahpur ...	Do.	1	1	1	7	1	...	1	2	27	10	9	5	12	8	3	1	5	38
	Total ...	10	5	10	51	15	3	3	20	211	58	58	28	95	92	34	7	52	186

NOTE.—The figures given above do not include the staff employed in the Bhera and Shahpur Sub-Divisions of the Shahpur Division, Lower Jhelum Canal.

APPENDIX D (1).

Statement showing average Annual Expenditure by Divisions and Sub-Divisions in the Lower Jhelum Circle.

Rasul Division.		Kirana Division.		Sargodha Division.		Shahpur Division.		Remarks.
Name of Sub-Division.	Expenditure.	Name of Sub-Division.	Expenditure.	Name of Sub-Division.	Expenditure.	Name of Sub-Division.	Expenditure.	
	Rs.		Rs.		Rs.		Rs.	
Executive	5,142	Executive ...	11,208	Executive ...	—20,416	Executive ...	18,661	
Head Works	2,95,432	Kirana ...	23,038	Mithalak ...	38,007	Ara ...	71,503	
		Khadir ...	25,208	Mangwana ...	41,978	Bhera ...	38,818	
		Hujjan ...	43,206	Shahjiwana ...	49,345	Shahpur ...	81,831	
		Lalian ...	21,549					
Total ...	3,00,574	...	1,26,383	...	1,08,914	...	2,10,813	

APPENDIX E.*

Rasul Head-Works.

Lower Jhelum Canal.

Rules for regulation of supply.

(*a*) The head-works of the Lower Jhelum Canal are shown on the plan, sheet 1 of Appendix II, and consist of a masonry weir across the River Jhelum, and a canal head regulator on the left bank of the river at the left flank of the weir. **Introductory.**

At the left flank of the weir, between it and the canal regulator, a certain length of the weir, known as the undersluices, is built at a level about 6·5′ lower than the rest of the weir, and fitted with gates for the purpose of scouring the river bed in front of the regulator free of silt deposits. The rest of the length of the weir is fitted with iron shutters hinged to the crest of the weir throughout i's length, which are capable of being raised erect, or laid prone, so as to raise or lower the water surface level of the river.

The general function of the weir and undersluices is to maintain the water surface level of the river at a certain minimum level during low water stages of its flow, and at a certain normal high level during normal high water stages of the river's flow.

When the discharge of the river does not exceed the requirements of the canal, all weir shutters are raised and all undersluices closed down completely; and the whole flow of the river is directed into the canal at the lowest convenient level.

As the flow of the river increases and exceeds the requirements of the canal, the excess is passed through the undersluices, the gates of which are opened up successively from the bottom upwards.

When all the undersluices are fully opened, if the river water level begins to rise above the fixed n rmal high level of 711·5, the weir shutters are dropped successively in order to pass off the excess over the weir proper and prevent the water level from rising above 711·5.

This level, 711·5, has been fixed so as to permit of passing water into the canal with the lowest possible velocity over a sill as high as possible, subject to practical limitations, for the purpose of excluding the coarser grades of river silt from passing into the canal.

An essential feature of the design is that the flow of the river through the undersluices shall always be under conditions of afflux calculated to scour the river bed in front of the canal regulator free of silt deposits.

Whenever the flow of the river exceeds the requirements of the canal there must always be a clean waterway through the undersluices under its lowest tier of gates for facility of underscour.

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*Plans referred to in this appendix are not printed.

Weir. (*b*) THE WEIR is inclined at 75° to the axis of the stream the right flank being up-stream. It consists of 8 bays, numbered from the left flank. Bay No. 1 is nearest the undersluices. The clear waterway of bay 1 is 487′ 8″, and of each of the remaining bays is 500′ : the level of the crest in bay 1 is R. L. 707·5, and each bay being 0·15′ higher than the bay on its left, the level in bay 8 is 708·55.

The bays were at first fitted with shutters 6′ wide and 4′ high ; these were replaced in April 1912 by shutters 3′ wide and 6′ high. There are 158 shutters in bay 1, and 164 shutters in each of the remaining bays : the shutters in bays 5 to 8 have been fitted with "Ashford's Patent Release Gear" ; by means of this, provided conditions be favourable, the shutters of a half bay can be dropped by working a lever on the pier flanking it : but the shutters are liable to be clogged with silt or weeds, and then the release gear sometimes fails to work. The shutters in bays 1 to 4 have to be dropped singly by knocking a catch from under a hook forming the end of a supporting tie-rod.

Between the bays are high masonry piers carried up well above flood level, as shown in the cross-section, sheet 2 of Appendix II : these piers are numbered in the same order as the bays, the pier on the right flank of any bay therefore bearing the same number as that bay. The piers are continued up and down-stream by groynes : the down-stream groynes are all similar ; the up-stream groynes of piers with even numbers are high stepped masonry structures founded on masonry wells as shown ; the others are of dry rubble, 3′ 6″ high only above crest of weir.

The piers carry standards supporting a wire rope-way on which a cradle is worked by hand, giving access to any pier in any state of the river. The standards also carry telephone wires to an instrument in the beldars' quarters on the right flank, connected to an exchange in the telegraph office ; the other instruments connected to the exchange are at the canal head gauge well, in the Executive Engineer's and in the Sub-Divisional Officer's bungalows.

The cross-section of the weir on sheet 2 of *Appendix II* shows the nature and arrangement of *foundation-wells, glacis,* aprons, and taluses.

Undersluices. (*c*) THE UNDERSLUICES have 12 spans each of 20′ clear, separated by 5′ piers : in addition to these, at the end nearer the weir, is a fish ladder 10′ wide. A road-way is carried across them by jackarches on longitudinal girders.

The bays were at first fitted with needles, but these were replaced in April 1910 by gates.

The gates are in 3 tiers, one above the other, and working in separate grooves ; each gate spans a bay ; there are therefore 36 gates for the twelve bays. The gates, starting with the lowest, are 3′ 3″, 4′ 3″, 5′ 3″ high, arranged to overlap each other by 3″ when in the closed position, resting on steps at the bottoms of their grooves : their bottoms are then at 0′, 3′ and 7′, and their tops at 3′ 3″, 7′ 3″ and 12′ 3″ above floor level. Floor level being R. L. 701·0 the top of the upper gate when lowered is 3″ lower than the tops of the shutters in bay 1 of the weir.

Each gate is fitted with chains by which it is raised or lowered, and by which it can be suspended at any height by means of hooks fastened at the tops of the groove castings.

A pair of travellers is provided, running on rails at road level, for working the gates ; these can all be lifted clear of high flood level. The travellers are moved by traversing gear : this can be coupled by a clutch to the raising gear, so that the traveller is automatically traversed at the right rate for keeping the suspension chains vertical as they are wound on the winding drums.

The floor is level throughout, details and arrangements being as shown in sheet 2 of Appendix II.

The undersluices are on a line in continuation of that of the weir, from which they are separated by a Divide Groyne : the latter, unlike the weir groynes, which are perpendicular to the line of the weir, is parallel to the axis of the river.

(*d*) The HEAD REGULATOR consists of 8 main spans of 24′ 6″ each separated by piers 4′ thick : two jack piers 2′ 6″ thick have been built in each bay, separating it into 3 spans 6′ 6″ clear each ; these jack piers carry arches crowned by a diaphragm wall filling the rest of the segment of the main arch. **Head Regulator.**

Floor level in the undersluice pocket, *i.e.*, bed level of river up-stream of regulator and in the canal is R. L. 701·0 ; there is a fixed crest of Hassan Abdal stone, 3′ high in each span : on this wooden karries weighted with iron, each 0·8′ high are used to form a temporary raised crest : the spans are closed off by lowering wooden gates strapped with iron, one gate for each span. The gates when up (open) are suspended on hooks built into the masonry. Two small travellers or crab-winches are provided for working the gates, and run on light rails over all the bays.

The floor is not countersunk for purpose of a watercushion ; the cross-section of the work is shown in sheet 2 of Appendix II.

(*e*) PROTECTIVE WORKS. The left bank of the river is high, and is pitched with stone for a length of 2,895 feet, the ends being turned in. On the right flank is a longitudinal bund, pitched and protected by an apron ; the ends are turned back to join the high bank of the river, crossing the channels in which it flowed before and during construction of the head-works. A small torrent, the Darapur Torrent, flows into the area within the right flank protection bund, and has been used to fill this area with silt ; its discharge is allowed to escape down-stream through a pitched gap left for the purpose. **Protective Works.**

Rules for working.

I—(1). In order to keep coarse silt out of the canal :

(*a*) Supply will, from the 1st April to the 30th September, be taken over a crest of not less than five karries in each bay of the regulator ; the karries, being each 0·8′ deep, form a cill at R. L. 708·0. During the rest of the year the crest may be reduced if the clearness of the water permits. **Working of Regulator and Regulation.**

When in winter staunching of the works becomes necessary to maintain supply in the canal, the karrie crest may be altogether omitted.

(*b*) Supply will be taken over the full length of the regulator crest, by keeping all twenty-four gates open ; except that two regulator gates may be slung from the crabs, to be used for finer regulation, because the large pool above the works responds but slowly to regulation by undersluices. This rule must be rigidly observed, except only as permitted for flood working.

(2) A water surface level of 711·5 on the gauge above regulator, being sufficient to give full supply in the canal over a regulator crest at R. L. 708·0, further rise must be prevented as far as possible by dropping weir shutters and opening the undersluices to the necessary extent. The manner of doing this is laid down in detail in the parts of the rules relating to the working of the weir and undersluices.

Rising flood. (3) During a rising flood, more regulator gates may be closed ; they may be dropped from their catches when river level is above 713·0 ; if the river is below that level, they must be lowered by the crabs. But such closing must be obviated as far as possible by promptly clearing the undersluices and dropping as many of the weir shutters as the flood may demand.

Closing of Canal. (4) As soon as the river rises to 714·0, the canal is to be closed altogether.

Regulating and Indenting Gauges. (5) The gauge on which statistical discharges are based is that at Ala, 14 miles down the canal. This gauge should be watched to foresee the necessity for a change of indent on the Rasul Flume gauge. The gauge at Ala was originally in the open canal ; since May 1916 the standard gauge has been that in a well on the discharge flume.

Indents. (6) Indents are met on the Ala gauge by regulating on the Rasul Flume gauge at R. D. 650 of the canal : an automatic recording gauge is fitted on this gauge-well.

(7) Ordinarily indents shall be changed only once a day and between 6-0 and 10-0 A.M., in order that the Ala gauge shall have time to steady to its proper value by the time of the evening reading, and that any difference the next morning shall call attention to variation of the regulating gauge during the night.

Rainfall. (8) If there is a local fall of rain exceeding 1″ in 3 hours or 2″ in 24 hours the supply in the canal should be reduced by 300 cusecs for 6 hours at least, and when raised again the full indents should be given by successive increments of 100 cusecs per hour. When the rainfall is 3″ in 24 hours the supply should be reduced by 1,000 cusecs with further reductions of 1,000 cusecs for each inch of rainfall in excess of 3″ in 24 hours.

Emergent Closures. (9) Emergent closure demanded by accidents, breaches, heavily silt laden water or other special circumstances other than floods as specified above, may at any time be ordered by the regulating officer. Intimation of the time of closing and probable duration and of the time of reopening

should be given to Superintending Engineer, and to all Executive Engineers and Sub-Divisional Officers of the canal.

(10) After a closure exceeding 6 hours in duration, the reopening should be gradual: during the first hour the head gauge may be raised gradually to 2′; it may then be raised by 0·5′ per hour till a gauge of 4′ is reached, or 1′ less than indent if that be less than 5′; after that the rate of increase may be 0·2′ per hour. These increases are to be given gradually, and not in one step at the beginning of the periods. **Opening Canal.**

(11) The regulator crab-winches shall be manned by not less than two nor more than four men each, to prevent a gate taking charge or the gearing being overstrained: the crabs shall be kept cleaned, lubricated and in proper order: the chains shall be annealed once a year. **Regulator Crab-winches.**

II—(1) The principle of regulation of the flow of the river at the canal regulator is to keep the water surface in the flood season no higher than 711·5, or whatever level below 711·5 is sufficient to satisfy the indent of the canal over a crest at R. L. 708·0. This must be done in the first instance by means of the weir shutters, the undersluices being kept fully open. But when all weir shutters are erect and still the river level is below requirements the undersluice gates shall be lowered in the order:— **Working of Undersluices.**

(1) Upper tier, (2) middle tier, (3) bottom tier throughout the waterway of the undersluices. So also, outside the flood season, the undersluice gates shall only be lowered after all weir shutters are up, and they shall be lowered in the order, upper, middle, lower tier.

All gates of each tier shall be kept as far as practicable at a uniform level, so as to distribute scour evenly across the entire width of waterway.

(2) On the occasion of a rising flood the wier shutters must be dropped first, and the undersluice gates raised afterwards, unless in a special emergency such as that contemplated in Rule III (3) it be necessary to accelerate the clearing of the sluice ways.

(3) With a falling flood the closing of undersluice gates to maintain indent in the canal should follow after the raising of the weir shutters.

(4) The travellers will be manned by not less than four nor more than 8 men each: the dropping of gates on the brake is absolutely forbidden. The travellers will be kept cleaned and lubricated and in repair; the chains shall be annealed once a year. The staff should be instructed in the use of the traversing gear.

III—(1) The crest of the weir is higher on the right flank, and inclined towards the left flank in order to keep the river from deserting the canal. **Working of Weir.**

(2) The order in which weir shutters shall ordinarily be dropped is now laid down to be as follows, serially bay by bay:—

Nos. 8, 7, 6, 5, 4, 3, 2, 1, *i.e.*, starting from the right flank and working regularly to the left. The order of raising is the reverse of that of

dropping. Shutters shall ordinarily be kept down sufficient to keep river level down to R. L. 711·5 on the gauge above regulator, as specified in Rule I (2).

(3) Simultaneously with the dropping of shutters from the right flank, dropping shall also be started from the left flank if the river rise to above R. L. 713·0 on the gauge above regulator, and may be continued to the extent necessary to obviate danger of overtopping shutters.

(4) After a flood the raising of shutters must be begun promptly and continued energetically to prevent silting the undersluice pocket, closing bays from the left flank as per Rule III (2).

Cable-way. (5) The cable-way must be watched to see that the cable is not untwisting, and that no wires snap : two kinks were allowed to occur in erection, one in bay 4 and one at the left anchorage, which slightly opened the coils ; these have been watched for two years and are not increasing. The saddles on each pier, carrying the cable, should be kept lubricated. The counter weight on the right flank must be kept off the bottom of the pit, and the winch rope kept slack, so that the weight may be free to maintain the correct tension in the cable.

The trolley-pulleys are made of bronze and are therefore much softer than the cable, so that all wear may take place on them ; they should be replaced before they wear too much and make running too heavy : new wheels should be made with the correct shape of groove ; the result of using an incorrect groove is that the rope rides at one side, and resistance is enormously increased by rubbing and cutting of the side of the pulley groove.

Flood Warnings. IV.—(1) Flood warnings received by State wire will, in the absence from Rasul of the Sub-Divisional Officer, be delivered to the canal signaller, who should communicate them to the head-works Subordinate and Jamadar, and signal them by canal wire to the head-works officers. Flood warnings despatched from Rasul will, in the absence of the Sub-Divisional Officer, be despatched by State or Canal wire by the canal signaller.

(2) The following flood warnings are received from points above Rasul :—

(*a*) KOHALA, by State urgent wire, whenever the river rises more than a foot between morning, noon and evening readings, stating amount of rise, time of rise and time during which gauge has risen. The effect at Rasul of equal floods at Kohala varies, but with the river at Rasul at about 711·0 and two bays of the weir open, the rise at Rasul is about a quarter of that at Kohala.

(*b*) MANGLA, by urgent canal wire, when the river rises more than a foot in six hours : this represents an increase of about 2,500 cusecs in cold weather conditions, about 10,000 cusecs at normal hot weather levels when Mangla River gauge is about 881′, and up to 30,000 cusecs when that gauge is about 884′.

(c) BONG, SAKETAR I and II, and JABBA TORRENT Crossings of the Upper Jhelum Canal, by urgent canal wire; these warnings specify the approximate escapage passed to the river.

Flood warnings are not received for the following torrents :—

(i) The KAHAN TORRENT on the right bank of the river, immediately below Jhelum; floods arrive before a wire conveying a flood warning could reach Rasul.

(ii) The BUNHAR TORRENT on the right bank of the river, immediately above Rasul; floods arrive with great suddenness and in considerable volume, and it is these that are most dangerous.

(3) Storm warnings, and three daily weather reports, are received by State wire from the Meteorological Department, and are placed on the canal wire by the signaller at Rasul for the benefit of all concerned.

(4) Warning is sent by State urgent wire to the Superintending Engineer, Derajat Circle, and to the Executive Engineers, Multan and Muzaffargarh, of all floods rising to or above 711·5 on the gauge below undersluices.

Navigation.

V—(1) No boat or raft is allowed to pass through the regulator into the canal. Boats and rafts are allowed to pass the works up or down the river, free of toll, but only with permission of the Sub-Divisional Officer, or in his absence of the Executive Engineer. Such permission shall only be given when a passage can be effected in safety and without damage to the works.

(2) When a boat or raft is seen on the river approaching the works it shall be stopped and compelled to tie up to the bank or to an island, at a safe point and a safe distance from the works. Meanwhile the orders of the Sub-Divisional Officer shall be taken regarding its passage.

(3) A boat or raft may be passed over any bay of the weir that may be open, provided that water level up-stream of that bay is not less than 3·5′ above the crest of that bay.

(4) When the weir cannot be passed, boats and rafts reduced to a width of 16′ may with the permission of Executive Engineer or Sub-Divisional Officer be passed through a bay of the undersluices as long as the depth of water on the floor below is not less than a-third of that above. The bay will be opened and reclosed as quickly as possible.

(5) The above rules for navigation consider only the safety of the works. Government accepts no responsibility in connection with damage to or loss of boats, rafts, goods and effects, crews or passengers.

Log-books and Gauges.

VI.—The Jemadar shall keep a log-book for the head-works in the vernacular: this is in printed form, and full orders regarding the posting of it are recorded in the book. An English log-book should be kept in the hut on the regulating gauge-well; in this the head-works subordinate will daily post a brief abstract of events from the Jemadar's log, and the head-works officers enter their inspections, as specified in detail in the

book. The Sub-Divisional Officer and Jemadar must show both log-books to Superintending Engineer each time he visits Rasul, or once every three months, whichever period is greater, and obtain his initials thereto.

The gauges to be read at head-works are shown in the prescribed form of gauge-register, in English and in Vernacular; these are to be read morning, noon and evening.

Soundings and Observations.

VII.—Appendix III contains a complete set of forms for the submission of periodical soundings of the head-works, etc., consisting of:—

(1) Regulation Diagram, showing fluctuation of river gauges and detailed working of the works during a month.

(2) Soundings of the Undersluice pocket, to show freedom from silt.

(3) Soundings below Undersluices, to show scour and any damage.

(4) Soundings at nose of Divide Groyne, to show any attack on this.

(5) Soundings at noses of T spurs below weir, to show any attack on these.

(6) Soundings in canal below regulator, to show safety of protection flooring.

(7) Soundings of bridge at R. D. 6,416, to show safety from scour.

(8) Soundings of the first five miles of Main Line, to show fluctuation of silting or scouring of bed.

(9) Soundings of up-stream noses of weir groynes, to show attack on them.

(10) Soundings of bays of the weir, to show safety of the aprons and taluses.

Of the above, Nos. 1, 2, 3, 4, 6, 7, 8 and 9 are taken monthly and submitted with the Progress Report. Nos. 2, 3, 4, 6 are also taken and submitted fortnightly from April to September, inclusive.

Nos. 5 and 10 only after each flood rising to 713·0 or more on the gauge below Undersluices.

No. 9 also fortnightly if the river has in the preceding fortnight risen to 713·0 or more on the gauge below Undersluices.

Annual Flood Report and River Survey.

VIII.—With the Annual Report on the head-works is submitted a survey of the river for 5 miles above and 2½ miles below the works: and a set of careful soundings and probings of the whole weir in forms 9 and 10.

Staff.

IX.—(1) It is the duty of the SUPERINTENDING ENGINEER to see that Regulation Rules are observed.

(2) It is the duty of the EXECUTIVE ENGINEER to watch regulation and working, and see that the rules are followed and staff kept up to the

mark: also during the flood season periodically to relieve the Sub-Divisional Officer of regulation as necessary to enable him to attend to duties elsewhere in his charge; at such times he assumes full responsibility for the working at Rasul.

(3) The duties of the SUB-DIVISIONAL OFFICER are :—

(a) to supervise the work of the staff, see that rules are followed, and that all measures necessary for safe and efficient working are duly taken;

(b) from the 15th June to the 30th September, not to leave Rasul for more than six hours at a time unless formally relieved of head-works by the Executive Engineer

(c) to issue in writing indents on the Regulating Gauge that will correctly meet indents at Fakirian, and to inform any officer whose indent cannot be met of the reason;

(d) to approve candidates for posts on the Regulating Staff, to drill them in their duties, and to keep them reasonably occupied at all times: to muster the staff unexpectedly to check unauthorised absence, and to record this in the log-book; during the flood season periodically but irregularly to visit the sentries at night, and record his inspection in the log-book.

(e) Personally to see that all gates, gearing and shutters are at all times in working order, painted and lubricated; to see that the boats are in order: that sufficient karries, hooks, rods and other tools are at hand and in order.

(4) The duty of the head-works SUBORDINATE is to take the prescribed soundings and discharges, and help the Sub-Divisional Officer with the duties specified above, as well as to exercise ordinary sectional superintendence of works and repairs;

(5) The following STAFF is employed solely for head-works :—

3 Gauge Readers.	1 Smith Mistry.
1 Jemadar.	1 Motor-boat Mistry.
1 Naib-Jemadar.	1 Boat Tindal.
25 Beldars.	6 Boat-men.

(6) The duties of the JEMADAR are :—

(a) To carry out regulation according to rules; to see that the works are safeguarded and supply regularly maintained.

(b) To arrange the programme of sentries, men on duty, and men ready to turn out at call; to see that the beldars do their duties, and to maintain discipline among them.

(c) To drill the boat-men and beldars in their duties, to report sick and inefficient men, and to recruit suitable men for vacancies, keeping the staff up to full strength.

To maintain the vernacular log-book as prescribed.

(e) To warn the Sub-Divisional Officer of floods, heavy rain, or other important occurrence, and to take his orders if necessary to drop weir-shutters, clear undersluices or open regulator more than the normal of ordinary regulation. Floods of which the Sub-Divisional Officer should be warned, night or day, are those rising to or above 712·5 with any shutters erect in bays 1 to 4 of the weir, to or above 714·0 with all shutters down.

(7) The NAIB-JEMADAR will assist the Jemadar in the above, taking duty by turns with him and calling him in case of any sudden rise or fall of the river or other important occurrence, and helping him where work has to be done simultaneously at several points.

(8) The GAUGE READERS will read, record and report the prescribed gauges at the prescribed times, and at the times of maxima of floods.

(9) The duties of the BELDARS are :—

(a) to patrol, keep clean and tidy the regulator, weir, undersluices and left bank protection works ;

(b) to patrol the right bank protection works and keep them clean and tidy ; to do any petty repairs needed and promptly report any defect requiring action ;

(c) to furnish sentries and patrols ; to keep the canal to indent and to pass floods ;

(d) at times at which more urgent flood or regulation-work is not in hand, and if the boatmen are insufficient, to help with sounding and discharges ;

(e) to keep all lamps, gearing, etc., clean.

(10) The SMITH MISTRY must see that all lamps are in working order ; that crabs and winches are lubricated and in order ; that gates and karries are in repair and not damaged ; that weir shutters are in working order, neither jamming nor dropping of themselves ; that the pulleys of rope-way trolleys are replaced when necessary, cable saddles lubricated, and the cable correctly strained by the counterweight.

(11) The MOTOR MISTRY is responsible for the good order of the boat motor, and will drive it when the boat is required.

(12) The TINDAL and the BOATMEN under him are responsible for all boats, and will man them when wanted ; they will help in taking soundings and discharges ; when not needed on the boats they should help the beldars, especially in passing floods.

APPENDIX F.

Regulation at Fakirian.

X.—(1) The gauge at tail of Main Line shall in no case exceed the minimum necessary to meet indent of all or any of the channels running, or a maximum limiting gauge of 9·0 ft. **Regulation at Fakirian.**

(2) Unavoidable small fluctuations of supply shall be distributed according to orders given from time to time. Supplies according to rotational working will be regulated by the Executive Engineer according to the system in force for such working.

(3) Copies of all wires relating to regulation at Fakirian shall be given to the Jemadar, who should comply with them in accordance with the above rules.

(4) The lower gates of the regulators shall be kept down and supply passed over them. The gates of each regulator shall be kept as far as possible at a uniform level.

(5) On the canal being closed at Rasul, reduction of the different channels in turn will be ordered by the Executive Engineer in accordance with the wishes of the Executive Engineers, Sargodha and Kirana Divisions, having due regard to any repairs required, calling for quick drying of any channel. The quickest way of drying all channels is to pass seepage through the Southern Branch into the Wan Escape. Seepage discharge is about 30 cusecs.

(6) On the canal being reopened after a closure, the channels at Fakirian will be re-opened with gauges—

Northern Branch	..	..	..	2·0
Southern Branch	..	..	..	2·0
Southern Feeder	..	..	..	1·5

and will then be raised at a rate not exceeding 0·2 per hour until indent is reached. The Jemadar will report to the Executive Engineer and Sub-Divisional Officer at Rasul, and to the Executive Engineer and Sub-Divisional Officer in charge of each channel, the time at which water reaches Fakirian, and at which he opens each channel.

(7) The Jemadar is responsible for the beldars and has full control over them; he must see that they know the working of winches and gear, that the men are present and sentries on the alert, and indents being maintained. He has no fixed hours on or off duty, but must inspect and patrol effectively. He must comply with indents in accordance with rules 2 and 4. He shall maintain a register showing changes of indent, when received and when effected, and actual gauges every three hours.

(8) The staff shall consist of six beldars, divided into two sets of three each: one set shall be on duty twelve hours at a time, changing at 6-0 A.M. and 6-0 P.M.; they shall change from day to night duty once a fortnight. The gang on duty shall all be present at the beldars' shed on

the regulator, and shall furnish a sentry to patrol and watch the gauges for two hours at a time : if supply of a branch varies from indent, he will call the others and correct it : if supply in the Main Line becomes excessive or deficient, he will call the Jemadar. The beldars not on duty will remain present at the beldars' quarters.

APPENDIX G.

RULES FOR THE DISTRIBUTION OF THE SUPPLIES OF THE JHELUM, CHENAB AND RAVI RIVERS BETWEEN THE UPPER JHELUM, LOWER JHELUM, UPPER CHENAB, LOWER CHENAB AND LOWER BARI DOAB CANALS.

Rule 1 (*b*).—Two proposals were made regarding the Jhelum River supply below Mangla ; one was to deduct the volume escaped below the Rasul Weir and the other to deduct the supplies taken by the Lower Jhelum Canal during every fourth period of ten days. The Lower Jhelum Canal has been compelled to use low supplies continuously that aggregate to more than it probably would have needed if given efficiently, *i.e.*, full supplies for a shorter period ; there appears to be no satisfactory method of legislating for such conditions, a working solution of the difficulty, *viz.*, to give the Lower Jhelum Canal full supply, irrespective of its share, during the balance supply turns of the Lower Chenab Canal was approved by the Chief Engineer. The escapage below the Rasul Weir has been considered as non-available river supply.

Rule 2 (*iii and iv*).—The distribution of the supply at Sambrial between the Upper Chenab Canal and the Lower Bari Doab Canal has been a difficult question. The main principle of sharing this supply in the ratio of supplies utilised has been followed and the natural advantage of the Upper Chenab Canal channels has been balanced by adding 10 per cent to their head supplies. Any method of calculating the actual absorption and sharing this volume involves the question of first ascertaining the supplies utilised in the Upper Chenab Canal channels and gives daily results that are generally quite unintelligible owing to the fluctuation of supply, the length of feeder channel and further fluctuations due to internal distribution. The method adopted has been agreed to by the Superintending Engineer, Lower Bari Doab Canal

Rules for the distribution of the supplies of the Jhelum, Chenab and Ravi Rivers between the Upper Jhelum, Lower Jhelum, Upper Chenab, Lower Bari Doab and Lower Chenab Canals.

1. (*a*) The river supplies available for distribution are—

(*i*) *Jhelum River.*—The total of the supplies gauged at Ala on the Lower Jhelum Canal and below Jaggu on the Upper Jhelum Canal.

(*ii*) *Chenab River.*—The total of the supplies gauged at Sambrial on the Upper Chanab Canal and at Chenawan on the Lower Chenab Canal.

(*iii*) *Ravi River.*—As gauged in the river above the Balloki Weir.

(b) From the above will be deducted—

(i) The absorption in the Upper Jhelum Canal between Jaggu and the tail inlet into the Chenab River less 10 per cent of the supply debited to the Upper Jhelum Canal when the Gujrat Branch or Main Line Distributaries are open.

(ii) The volumes passed below the Weir at Balloki in compliance with the indents of the Sidhnai Canals.

(iii) The supplies utilised in kharif channels between 1st October and the 15th October when all kharif channels are to be closed.

2. The supplies to be debited to each Canal are—

(i) *The Upper Jhelum Canal.*—As gauged at the heads of the Gujrat Branch and the Main Line Distributaries *plus* 10 per cent for their share of the absorption between Jaggu and the tail inlet.

(ii) *Lower Jhelum Canal.*—As gauged at Ala.

(iii) *Upper Chenab Canal.*—A share of the supply gauged at Sambrial in the ratio of X to Y where X is the total of the supplies gauged at distributary heads *plus* 10 per cent as their share of the absorption, and Y is the supply gauged at R. D. 423,000 feet, Main Line Lower.

(iv) *The Lower Bari Doab Canal.*—The supplies gauged in the canal at its Head or 128 per cent of the aggregate full capacities of all of its Distributaries which may be in flow at any time : whichever volume is the greater.

(v) *The Lower Chenab Canal.*—As gauged at Chinanwan *plus* escapage at Chinanwan.

3. The shares of the canals are—

(i) *Original shares of the Lower Jhelum and Lower Chenab Canals.*—The shares are proportional to the rabi areas. The areas proposed to be irrigated annually by the complete project furnish the data for the original shares in the river ; the areas in excess of this that have since been attained should be provided for with the areas irrigated from the Triple Project.

On the Lower Chenab Canal the rabi area is to be three-fifths of the annual and the normal rabi is now 1,600,000 acres.

On the Lower Jhelum Canal the rabi area is to be two-thirds of the annual and the normal rabi is now 600,000 acres.

Using the figures in statement 1-A of the Administration Report for 1914-15, the following are the areas to be considered in fixing the shares :—

Name of Canal.	Area proposed to be irrigated annually by the complete project.	Corresponding rabi area for use in calculating original shares.	Normal rabi.	Rabi area to share with the Triple Project.
	Acres.	Acres.	Acres.	Acres.
Lower Chenab Canal ...	1,488,351	893,010	1,600,000	706,990
Lower Jhelum Canal ...	668,921	412,614	600,000	187,386
Total ...	2,157,272	1,305,624	2,200,000	894,376

(*ii*) *Shares of the Triple Canal Project.*—The area figures are as follows :—

Name of Canal.	Ratio of kharif to rabi.	Kharif on perennial channels.	Rabi.	Total.	Kharif on kharif channels only.	First and last waterings.
		Acres.	Acres.	Acres.	Acres.	Acres.
Upper Jhelum Canal ...	1 to 1	131,148	131,148	262,296	43,199	21,600
Upper Chenab Canal ...	1 to 1·5	161,405	242,116	403,521	201,128	40,218
Lower Bari Doab Canal	1 to 1·5	372,038	518,149	890,187	-	...
Total ...	...	664,591	891,413	1,556,004	244,327	61,818

(*iii*) *Duty for calculating shares.*—For the purpose of calculating shares the rabi canal head duty for all five canals may be taken at 200 acres per cusec.

The shares will be as follows :—

Canal.		Rabi area.	Discharge at 200 acres per cusec.	
		Acres.		
Original shares to be first met ...	Lower Chenab ...	893,010		(*a*) 4,465
	Lower Jhelum ...	412,614		(*c*) 2,063
	Total ...	1,305,624		6,528
Shares in the surplus over the above	Lower Chenab ...	706,990		(*b*) 3,535
	Lower Jhelum ...	187,386		(*d*) 937
	Upper Jhelum ...	131,148	656	4,456
	Upper Chenab ...	242,116	1,210	
	Lower Bari Doab ...	516,149	2,590	
	Total ...	1,765,789		8,928
	GRAND TOTAL ...	3,071,413		15,456

$a + b = 8{,}000.$

$c + d = 3{,}000.$

(*iv*) Shares of balance of total available river supplies after deducting the combined original shares of the Lower Chenab and Lower Jhelum Canals will be :—

Lower Chenab Canal	...	$\frac{3535}{8928} \times 100 = 39 \cdot 60$ per cent.
Lower Jhelum Canal	...	$\frac{937}{8928} \times 100 = 10 \cdot 50$,, ,,
Upper Jhelum Canal	...	$\frac{656}{8928} \times 100 = 7 \cdot 34$,, ,,
Upper Chenab Canal	...	$\frac{1210}{8928} \times 100 = 13 \cdot 55$,, ,,
Lower Bari Doab Canal	...	$\frac{2590}{8928} \times 100 = 29 \cdot 01$,, ,,

4. Deficiencies in shares should be made good promptly.

5. Shares are quenched to the extent to which water is available, when indents are complied with ; this governs reductions of indents for closing breaches and for other internal reasons.

6. No Canal is to be debited with the supplies taken over and above its shares provided that the indents of all other canals are complied with. This governs excess river supplies due to fre hets, etc.

7. Shares are to be calculated from the 1st of October.

8. The water account is to be calculated on morning discharges ; the special Sub-Divisional Officer in charge of the water account will post copies of the daily account each day and the 10 days balance accounts promptly to all Superintending Engineers and Executive Engineers.

Distribution of the supply available in the Jhelum, Chenab and Ravi Rivers.

DATE.	RIVER SUPPLIES AVAILABLE FOR DISTRIBUTION.											
	Chenab.				*Jhelum.*				*Ravi.*			
	Upper Chenab Canal at Sambrial.	Lower Chenab Canal at Chinanwan.	Upper Jhelum Canal at tail.	Total columns 1 + 2 — 3.	Upper Jhelum Canal at Jaggu.	Lower Jhelum Canal at Ala.	Absorption in Upper Jhelum Canal.	Total columns 5 + 6 — 7.	Above Balloki.	Below Balloki.	Total columns 5 + 10.	Total columns 4 + 8 + 11.
	1	2	3	4	5	6	7	8	9	10	11	12
B. Over												
Total												

Superintending Engineer,

____________*Canal.*

Sub-Divisional Officer,

Discharges.

Distribution between canals.

Date.	Upper Jhelum Canal.			Lower Jhelum Canal.				Lower Chenab Canal.			
	Share.	Perennial Channels + 10% AB.	Excess + Deficiency —	Share.	Ala.	Escapage below Rasul.	Excess + Deficiency —	Share.	Chinanwan.	Escapage below Khanki.	Excess + Deficiency —
	1	2	3	4	5	6	7	8	9	10	11
B. Over ...											
Total ...											

Superintending Engineer,
————— Canal.

Sub-Divisional Officer,
Discharges.

	Upper Chenab Canal.						Lower Bari Doab Canal.				
	Share.	Sambrial.	423,000 feet.	Perennial channels + 10% AB.	Share of actual at Sambrial, cols. $\frac{15}{14+15} + 13$.	Excess + Deficiency —	Share.	Share of actual at Sambrial, cols. $\frac{14}{14+15} + 13$.	From Ravi.	Total.	Excess + Deficiency.
	12	13	14	15	16	17	18	19	20	21	22
B. over ...											
Total ...											

Superintending Engineer,
————— Canal.

Sub-Divisional Officer,
Discharges.

Distribution of river supplies. ————— *Date*

River supplies.		Distribution between canals.			
Columns.	Supplies.	Columns.	Supplies.	Columns.	Supplies.
		1		12	
		2		13	
		3		14	
		4		15	
		5		16	
		6		17	
		7		18	
		8		19	
		9		20	
		10		21	
		11		22	

Note—

Sub-Divisional Officer,
Discharges.

APPENDIX H.

Statement showing Occupiers' Rate in force on the Lower Jhelum Canal.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.			Rate per acre. Lift.			Per.
			Rs.	A.	P.	Rs.	A.	P.	
Irrigation Branch notification No. 07-R.I., dated 28th May 1902.	I	Sugarcane, waternuts ...	10	0	0	5	0	0	Crop.
	II	Rice	6	4	0	3	2	0	Do.
	III	Orchards, gardens, tobacco, indigo, vegetables, drugs, poppy and melons.	5	0	0	2	8	0	Orchards and gardens per half year; the rest per crop.
	IV	Cotton, fibres, dyes (other than indigo), oilseeds, maize and all rabi crops except gram and masur.	3	12	0	1	14	0	Crop.
	V	All other kharif crops, gram and masur, and all crops grown for fodder.	2	8	0	1	4	0	Do.
Irrigation Branch notification No. 632-R.I., dated 12th May 1913.	VI	Single watering before ploughing, not followed by a canal irrigated crop in the same or next harvest. Crops grown on the "Wadh" or moisture of a previous crop.	1	4	0	0	10	0	Do.
	VII	Single watering, before ploughing for rabi followed by a rabi crop, to be applicable only to channels selected by the Local Government.	2	8	0	1	4	0	Do.
Irrigation Branch notification No. 0121-R.I., dated 21st September 1903, No. 310-R.I., dated 19th December 1905, and No. 695-R-I. dated 11th December 1907.	VIII	Grass village plantations in Colony Villages and District Board plantations in the Colony—							
		For any number of waterings in the kharif season.	1	4	0	0	10	0	Half-year.
		For one watering in the rabi season.	1	4	0	0	10	0	Do.
		For two or more waterings in the rabi season.	2	8	0	1	4	0	Do.

Statement showing Occupiers' Rate in force on the Lower Jhelum Canal—contd.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.	Rate per acre. Lift.	Per.
			Rs. A. P.	Rs. A. P.	
		Applicable to— (1) All villages or portions of villages in the Bhera Tahsil irrigated from the Khadir Feeder or Khadir Distributary. (2) All villages in the Shahpur Tahsil, except Sher Muhammad w a l a and Wegowal and except all villages or portions of villages irrigated from the Sahiwal Feeder including the Sahiwal Distributary and Gondal Distributary. (3) The following villages in the Sargodha Tahsil:— Northern Branch Chaks:— Nos. 89, 93, 94, 95, 103, 104, 105, 108, 110, 112, 115 to 174 inclusive. Southern Branch Chaks: Nos. 60, 61, 63, 131, 133, 134, 135, 137 to 141 inclusive and Chak Jodh on the Khadir Distributary.			
Irrigation Branch notification No. 408-R.I., dated 20th March 1912 and No. 438-R.I., dated 3rd April 1912.	I	Sugarcane and waternuts ...	7 8 0	3 12 0	Crop.
	II	Rice	4 0 0	2 0 0	Do.
	III	Orchards, gardens, indigo, vegetables, drugs and melons	5 0 0	2 8 0	Orchards and gardens per half year; the rest per crop.
	IV	Wheat	3 4 0	1 10 0	Crop.
	V	Cotton and oilseeds ...	3 0 0	1 8 0	Do.
	VI	Fibres (other than cotton), dyes (other than indigo), maize and all rabi crops other than wheat, gram, and masur.	2 8 0	1 4 0	Do.
	VII	All other kharif crops, gram, masur and all crops grown for fodder (including turnips).	2 0 0	1 0 0	Do.

Statement showing Occupiers' Rate in force on the Lower Jhelum Canal— concld.

Authority.	Class.	Nature of crops.	Rate per acre. Flow.	Rate per acre. Lift.	Per.
			Rs. A. P.	Rs. A. P.	
Irrigation Branch notification No. 632-R.I., dated 12th May 1913.	VIII	Single watering, before ploughing not followed by a canal irrigated crop in the same or next harvest.	1 4 0	0 10 0	Each watering.
		Crops grown on "Wadh" or moisture of a previous crop.			Crop.
	IX	Single watering, before ploughing for rabi followed by a rabi crop to be applicable only to channels selected by the Local Government.	2 8 0	1 4 0	Crop.
	X	Grass village plantations in Colony villages and District Board plantations in the Colony—			
		For any number of waterings in the kharif season.	1 4 0	0 10 0	Half-year.
		For one watering in the rabi season.	1 4 0	0 10 0	Do.
		For two or more waterings in the rabi season.	2 8 0	1 4 0	Do.

APPENDIX I.

Statement showing average number of magisterial cases per annum dealt with by officers and the number of cases settled out of court during the 5 years ending 1919-20 in Lower Jhelum Circle.

—	Rasul Division.		Kirana Division.		Sargodha Division.		Shahpur Division.		Total.		Remarks.
	Cases tried.	Cases settled out of court.	Cases tried.	Cases settled out of court.	Cases tried.	Cases settled out of court.	Cases tried.	Cases settled out of court.	Cases tried.	Cases settled out of court.	
Executive Engineer ...	...	...	1	...	...	...	...	...	1	...	
Sub-Divisional Officer ...	...	...	5	3	1	...	8	2	14	5	
Deputy Collector ...	...	...	49	45	26	56	16	9	91	110	
Total ...	...	...	55	48	27	56	24	11	106	115	

APPENDIX J.

List of Flour Mills, Lower Jhelum Canal.

Name of Division.	Name of Flour Mill.	Number of stones.	Sale price realized in 1917-18.	REMARKS.
Kirana Division ...	Gird wheel Mills at R. D. 16,000 Khadir Feeder.	6 pairs stones ...	Not yet let owing to unsuitable local conditions (unrented).	These mills are unworkable owing to remoddelling of the feeder, whereby the fall has been reduced.
			Rs. A. P.	
Sargodha Division ...	Turbine Mills at R. D. 24,560 Northern Branch.	5 pairs stones ...	21 4 0 per diem.	
Ditto ...	Turbine Mills at R. D. 64,500, Northern Branch.	Ditto ...	14 0 0 " "	
Ditto ...	Gird wheel Mills at R. D 343,720 Northern Branch.	Ditto ...	10 0 0 " "	
Shahpur Division ...	Gird wheel Mills at R. D. 13,500 Sulki Branch.	10 pairs stones ...	41 5 0 " "	

APPENDIX K.

A.—List of statistical statements of irrigation, water distributions and working of Distributaries.

1. Statement showing Discharges, Escapages, and water utilised during the year.

2. Abstract of irrigation in acres in each tahsil for the year.

3. Working Statistics of Distributaries for the year.

4. Rainfall statement at selected stations in inches.

5. Water consumption diagram.

B.—List of statistical returns of Revenue Expenditure and Working.

Form I.—Capital expenditure up to date by main heads of classification.

Form II.—Financial results.

Form III.—Account of Revenue collections by main heads.

Form IV.—Account of Revenue Expenditure by main heads

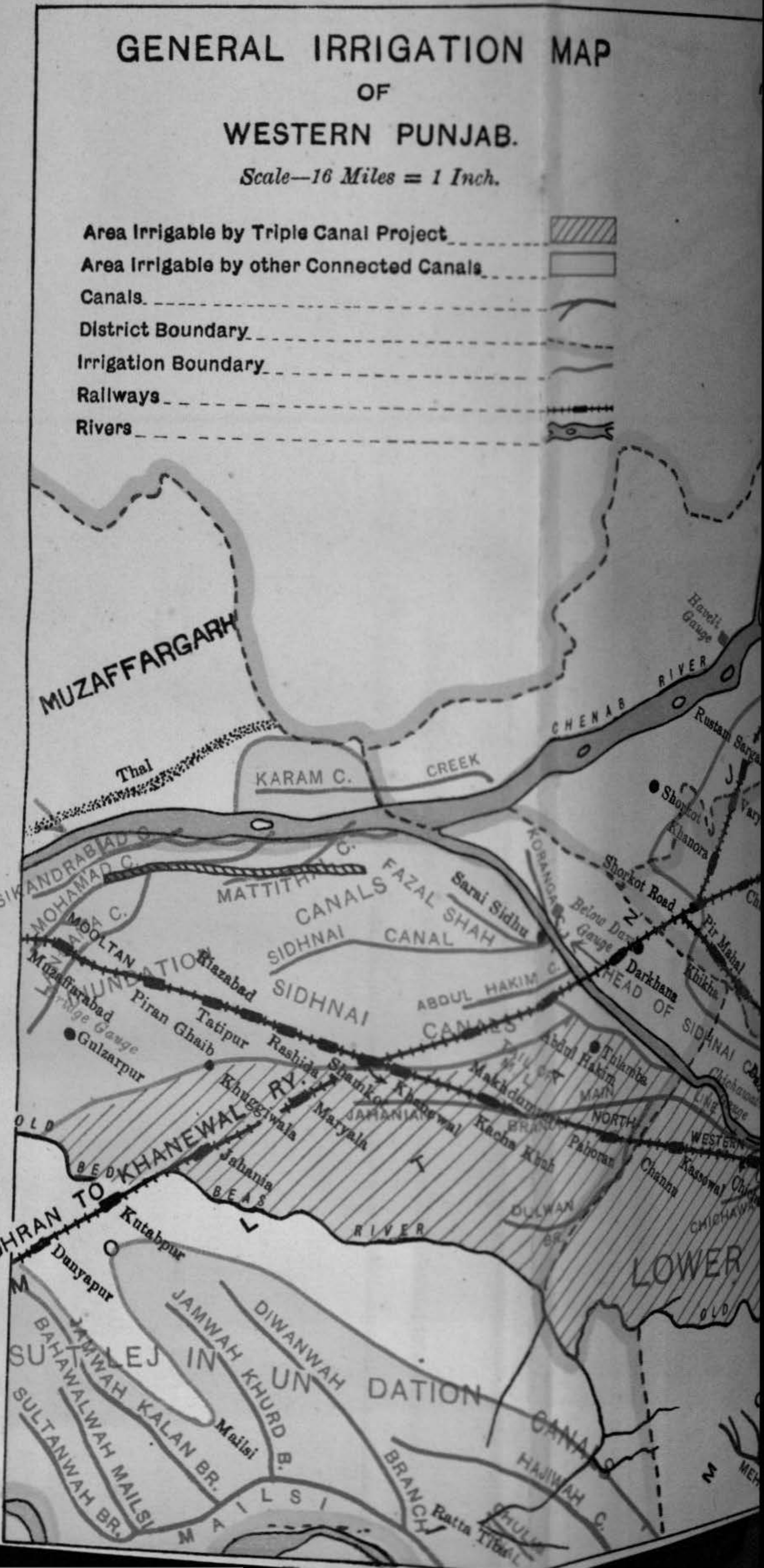
Form V.—Details of direct establishment charges.

Form VI.—Details of Receipts.

Form VII.—Acreage rate of occupiers' rates in each harvest.

Form VIII.—Area irrigated, supply and duty.

Form IX.—Statement giving the principal crops in each harvest and an abstract by classification according to water-rate schedules.


GENERAL IRRIGATION MAP
OF
WESTERN PUNJAB.
Scale—16 Miles = 1 Inch.
Area Irrigable by Triple Canal Project
Area Irrigable by other Connected Canals
Canals
District Boundary
Irrigation Boundary
Railways
Rivers
MUZAFFARGARH
Thal
KARAM C.
CREEK
CHENAB RIVER
Haveli Gauge
Rustam
Shorkot
Khanora
Shorkot Road
Pir Mahal
Darkhana
Below Dam Gauge
Sarai Sidhu
FAZAL SHAH
SIKANDRABAD C.
MOHAMAD C.
MATTITHAL C.
CANALS
SIDHNAI CANAL
SIDHNAI
SIDHNAI CANALS
ABDUL HAKIM C.
HEAD OF SIDHNAI
KORANGA C.
MOOLTAN
INUNDATION
Riazabad
Muzaffarabad
Piran Ghaib
Tatipur
Rashida
Gulzarpur
Shamkot
Khanewal
Abdul Hakim
Tulamba
Makhdampur
Khuggiwala
Maryala
JAHANIAN
MAIN LINE
NORTH
BRANCH
Kacha Khuh
Pahoran
Channu
Kassowal
WESTERN
LODHRAN TO KHANEWAL RY.
OLD BED
Jahania
BEAS RIVER
Kutabpur
Dunyapur
DULWAN BR.
LOWER
SUTLEJ INUNDATION CANALS
JAMWAH KHURD B.
DIWANWAH BRANCH
JAMWAH KALAN BR.
BAHAWALWAH
BAHAWALWAH MAILSI
SULTANWAH BR.
Mailsi
MAILSI
Ratta Tibba
HAJIWAH C.


GENERAL IRRIGATION MAP
OF
WESTERN PUNJAB.
Scale—16 Miles = 1 Inch.
Area Irrigable by Triple Canal Project
Area Irrigable by other Connected Canals
Canals
District Boundary
Irrigation Boundary
Railways
Rivers
UPPER JHELUM
LOWER JHELUM CANAL
LOWER CHENAB CANAL
UPPER CHENAB CANAL
LOWER BARI DOAB CANAL
UPPER BARI DOAB
CHENAB RIVER
RAVI RIVER
JHELUM RIVER
MUZAFFARGARH
F. W. WOODS,
Chief Engineer,
Irrigation Works Punjab.

LOWER JHELUM CIRCLE

TYPICAL PLAN OF A VILLAGE IN JHELUM COLONY

SCALE 1 INCH = 220

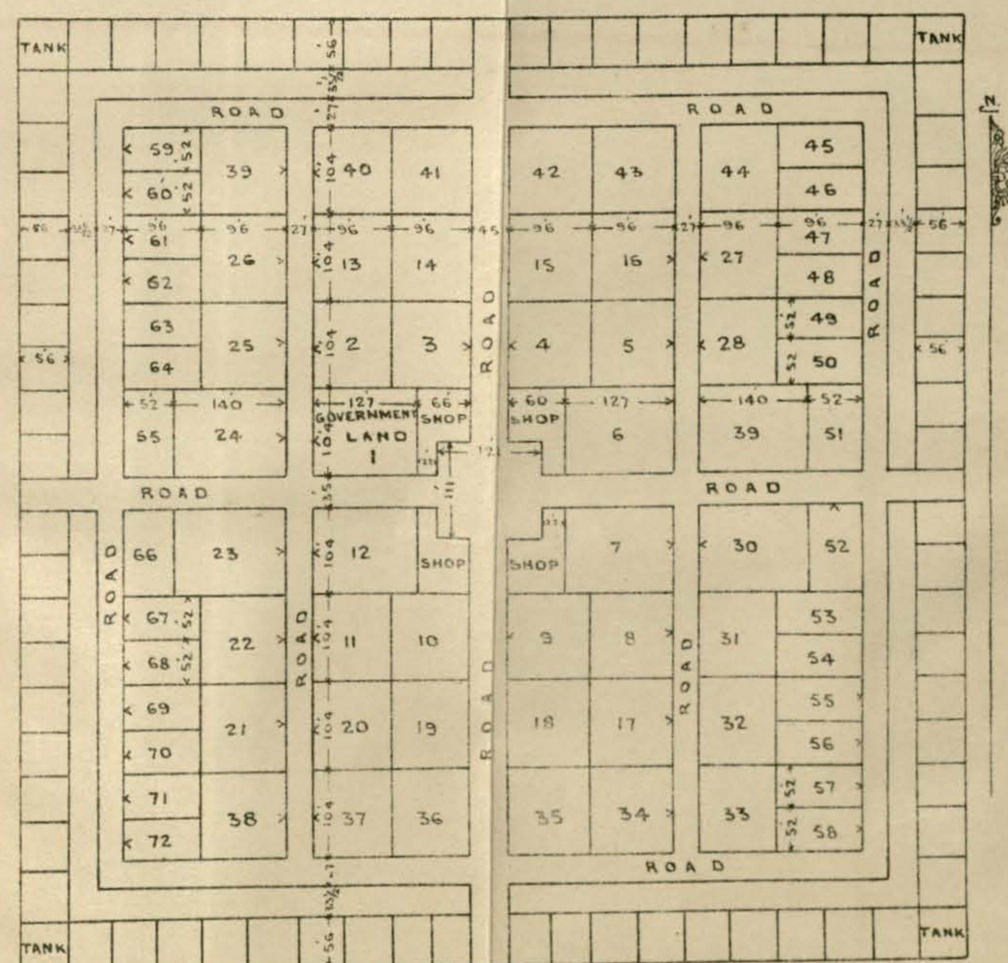
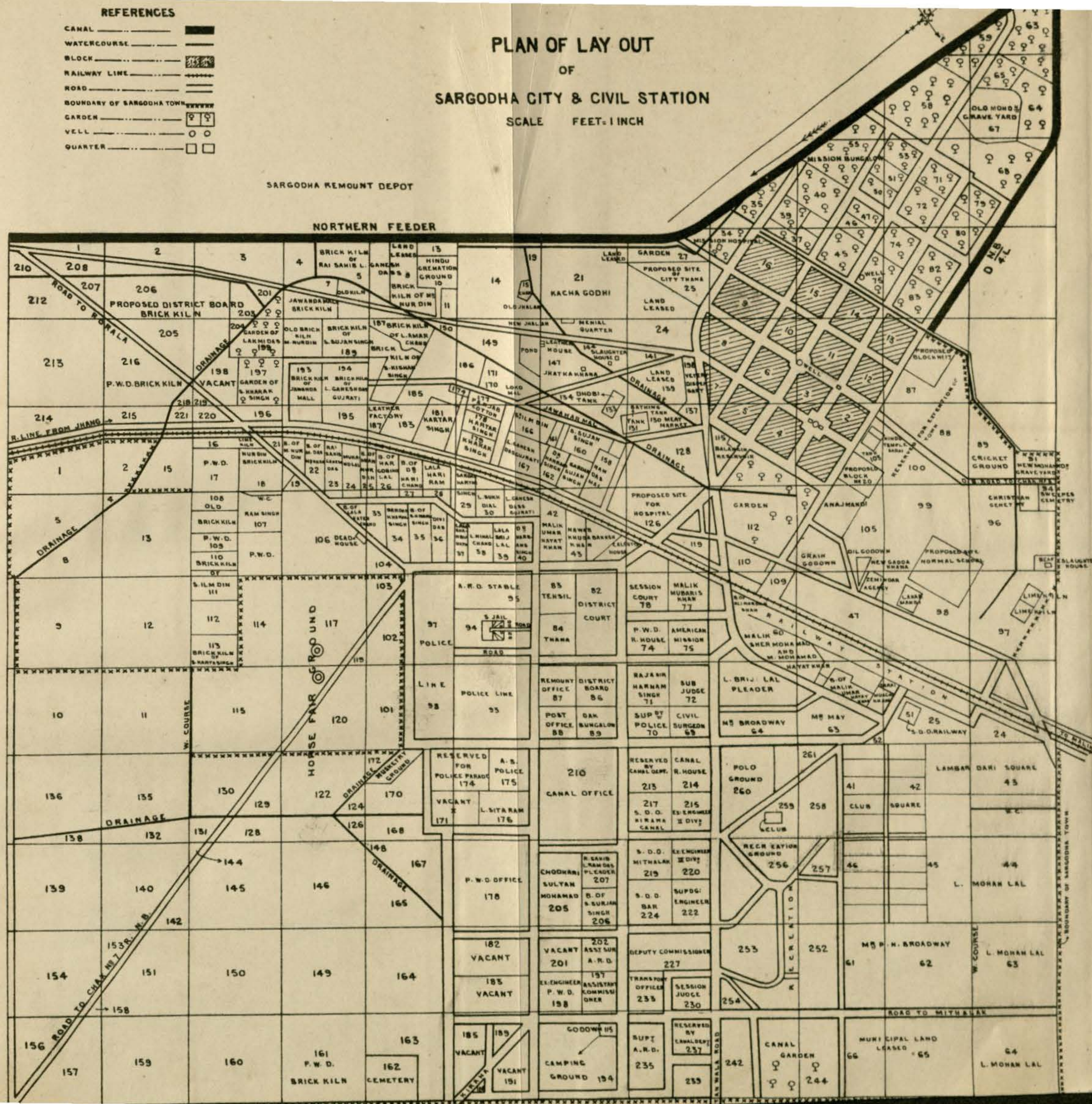
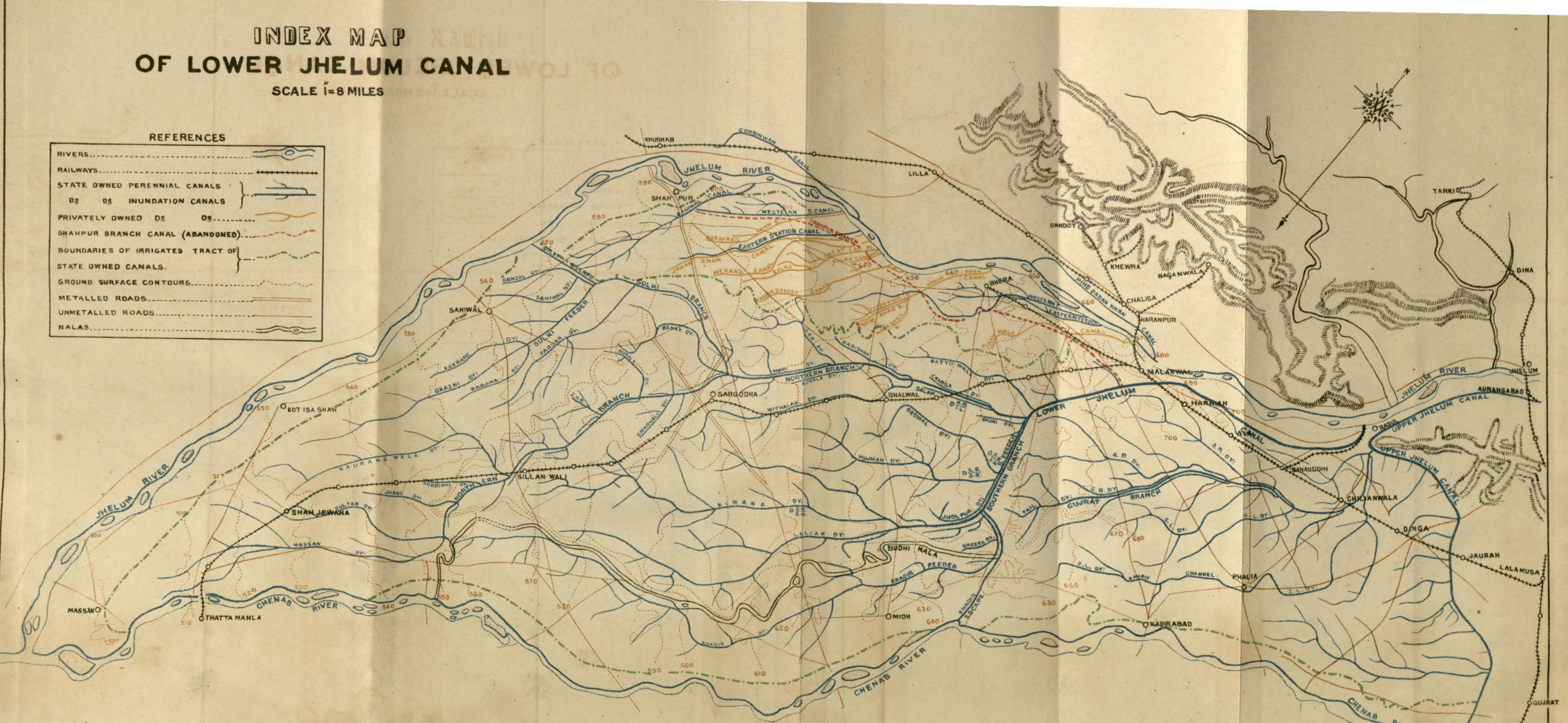


Photo.-Mechl. and Litho. Dept., Thomason College, Roorkee.

January, 1921.—No.2106.205.


PLAN OF LAY OUT
OF
SARGODHA CITY & CIVIL STATION
SCALE FEET= I INCH
REFERENCES
CANAL
WATERCOURSE
BLOCK
RAILWAY LINE
ROAD
BOUNDARY OF SARGODHA TOWN
GARDEN
WELL
QUARTER
SARGODHA REMOUNT DEPOT
NORTHERN FEEDER
ROAD TO BORALA
PROPOSED DISTRICT BOARD BRICK KILN
P.W.D. BRICK KILN
R. LINE FROM JHANG
DRAINAGE
W. COURSE
HORSE FAIR GROUND
ROAD TO CHAK NO. 7 R. N.B.
KACHA GODHI
HINDU CREMATION GROUND
MISSION BUNGALOW
OLD HINDU GRAVE YARD
CRICKET GROUND
CHRISTIAN CEMETRY
PROPOSED SITE FOR HOSPITAL
POLICE LINE
TEHSIL
DISTRICT COURT
THANA
SESSION COURT
REMOUNT OFFICE
DISTRICT BOARD
POST OFFICE
DAK BUNGALOW
CANAL OFFICE
P.W.D. OFFICE
CAMPING GROUND
CEMETERY
POLO GROUND
CLUB
RECREATION GROUND
CLUB SQUARE
LAMBARDARI SQUARE
DEPUTY COMMISSIONER
CANAL GARDEN
ROAD TO MITHALAK
MUNICIPAL LAND LEASED
L. MOHAN LAL
RAILWAY STATION
TO MALAKWAL
BOUNDARY OF SARGODHA TOWN



F. W. WOODS,
Chief Engineer, Irrigation Works.